Issued December 1966

SOIL SURVEY
GRAY COUNTY
Texas

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
TEXAS AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was done in the period 1958-62. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1965. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station; it is part of the technical assistance furnished to the Gray County Soil Conservation District.

HOW TO USE THIS SOIL SURVEY REPORT

THIS SOIL SURVEY of Gray County, Tex., contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

Locating Soils

All the soils of Gray County are shown on the detailed map at the back of this report. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units, Capability Units, and Range Sites" can be used to find information in the report. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for the capability unit, range site, or any other group in which the soil has been placed.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils in the soil descriptions and in the discussions of the interpretative groupings.

Game managers, sportsmen, and others concerned with wildlife will find information about soils and wildlife in the section "Use of the Soils for Wildlife."

Ranchers and others interested in range can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range, and also the plants that grow on each range site.

Engineers and builders will find, under "Engineering Uses of Soils," tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

Scientists and others can read about how the soils were formed and how they are classified in the section "Formation, Classification, and Morphology of Soils."

Students, teachers, and others will find information about soils and their management in various parts of the text, depending on their particular interest.

Newcomers in Gray County may be especially interested in the section "General Soil Map," where broad patterns of soils are described.

***Cover picture.*—Harvesting irrigated grain sorghum in a field of Pullman clay loam, 0 to 1 percent slopes.**

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NOTICE TO LIBRARIANS

Series year and series number are no longer shown on soil surveys. See explanation on next page.

Issued December 1966

EXPLANATION

Series Year and Series Number

Series year and number were dropped from all soil surveys sent to the printer after December 31, 1965. Many surveys, however, were then at such advanced stage of printing that it was not feasible to remove series year and number. Consequently, the last issues bearing series year and number will be as follows:

Series 1957, No. 23, Las Vegas and Eldorado Valleys Area, Nev.
Series 1958, No. 34, Grand Traverse County, Mich.
Series 1959, No. 42, Judith Basin Area, Mont.
Series 1960, No. 31, Elbert County, Colo. (Eastern Part)
Series 1961, No. 42, Camden County, N.J.
Series 1962, No. 13, Chicot County, Ark.
Series 1963, No. 1, Tippah County, Miss.

Series numbers will be consecutive in each series year, up to and including the numbers shown in the foregoing list. The soil survey for Tippah County, Miss., will be the last to have a series year and series number.

SOIL SURVEY OF GRAY COUNTY, TEXAS

BY JACK C. WILLIAMS AND ANTHONY J. WELKER, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE TEXAS AGRICULTURAL EXPERIMENT STATION

GRAY COUNTY, in the east-central part of the Texas Panhandle (fig. 1), has a total area of 943 square miles. It is about 30 miles square. Pampa, the county seat, is in the northwestern part of the county. In 1960, the county had a population of 31,535.

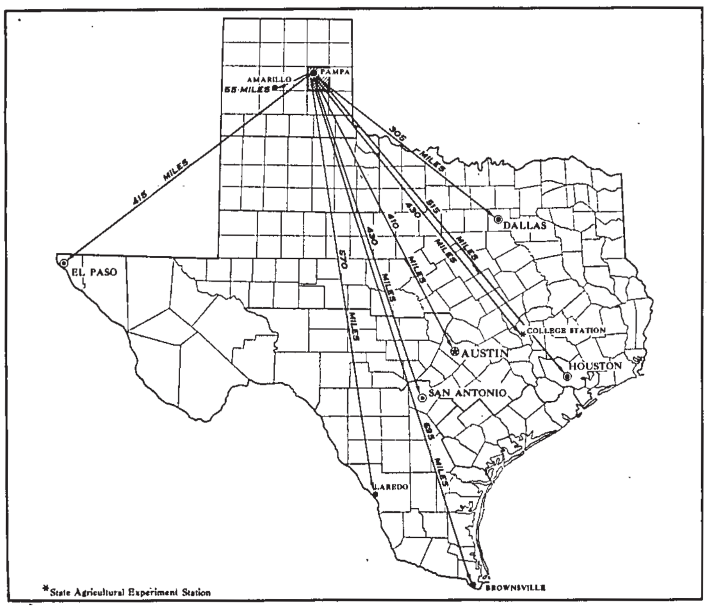

Figure 1.—**Location of Gray County in Texas.**

Settlers came to the area that is now Gray County in the late 1870's and 1880's and established several large cattle ranches. The county was not officially organized until 1902. In the early 1900's, a large acreage of native grassland was plowed up, and the settlers began to grow crops on land that had formerly been used for range.

Most of the county's industrial development has been in oil and gas and in services related to those industries, including the manufacture of heavy machinery and petrochemicals. Other industries are those related to farming and ranching. U.S. Highway No. 66 (Interstate Highway No. 40), U.S. Highway No. 60, and Texas Highways Nos. 152, 273, and 70 link all parts of the county. Bus and truck lines, as well as three railroads, connect the county with distant cities. Perry Lefors Airfield, northwest of Pampa, serves many industrial and private aircraft.

At present, most of the High Plains area in the western and northern parts of the county is cultivated, and wheat and grain sorghum are the main crops. To some extent, grain and forage crops are grown under irrigation in this area. The rest of the county is rolling, and the raising of cattle is the principal agricultural enterprise. Small grains, forage crops, and cotton are grown on some of the smoother areas in the eastern and southeastern parts of the county.

Physiography, Relief, and Drainage

This county is in the Great Plains province. It is divided into the High Plains and the Rolling Plains land resource areas.

The High Plains part of the county is a nearly level to gently sloping plain that extends into Roberts County to the north and into Carson, Donley, and Armstrong Counties to the southwest. The slope of the plain is a few feet per mile to the southeast. The soils of the High Plains are dark and fine textured.

The Rolling Plains extend to the east and north as the Ogallala formation feathers out. Relief is rolling in most places and is steepest near the edge of the High Plains. The streams in the area are entrenched to a depth of several hundred feet in some places. The area slopes away from the edge of the High Plains. Generally, the soils are more sandy with distance from the edge of the High Plains.

Only a small amount of water runs off the High Plains. Most of the water flows into saucerlike depressions called playa lakes. The water remains in these lakes until it evaporates.

Steep, well-defined drainageways occur at the edges of the High Plains. Drainage to the north flows into the Canadian River. To the east, drainage is into the North Fork Red River, which is the major drainage system in the county. McClellan Creek is a major stream that flows eastward across the southern part of the county and into the North Fork Red River. In the extreme southeastern part of the county, drainage from a small area is southward into the Salt Fork Red River.

The only lake of importance in the county is Lake McClellan. It is on McClellan Creek.

Many springs and seeps occur in the southeastern third of the county. Many of the streams there have running

water in them throughout the year or for several months at a time.

Geology

The Permian red beds of the Paleozoic era make up the oldest exposed geological formation in the county. They are exposed in the central, eastern, and southern parts of the county, along the North Fork Red River, McClellan Creek, and the tributaries of those streams. Following the uplift from which the present-day Rocky Mountains were carved, eastward-flowing streams deposited a large quantity of gravel, sand, and silt over the red beds. These deposits are several hundred feet thick in places and make up the Ogallala formation. The present surface of the High Plains conforms to the surface of the Ogallala formation. The eroding away of the eastern edge of this formation resulted in its feathering out in that direction.

During the Pleistocene epoch, eolian and loessal deposits capped the Ogallala formation (*4*).[1] These deposits range from a few feet to well over 100 feet in thickness (*10*). The nearly level High Plains south of the Canadian River are called the Llano Estacado. During the Late Pliocene or early Pleistocene epoch, thin beds of stratified sand, sandy clay, and lentils of gravel were deposited over much of the Rolling Plains east of the Llano Estacado (*6*). These deposits are the parent material of the Miles and Springer soils that are on broad ridges in the southeastern part of the county.

Deposits of the Recent epoch consist mainly of sand dunes, sheets of windblown material, and valley fill. These deposits make up the parent material of the Tivoli soils.

[1] Italic numbers in parentheses refer to Literature Cited, p. 72.

Geological erosion continues to slowly cut away the edges of the High Plains, and downward and lateral erosion by streams continues to cut into the Ogallala formation and the Permian red beds. Wind erosion continues to rework many surfaces, particularly those of the sandy soils, such as the Miles, Springer, and Likes.

The gravel, sand, and silt of the Ogallala formation form one of the largest natural underground water reservoirs in this part of the country. So far as is known, the only recharge of the water supply in this reservoir is by infiltration of a small amount of rainfall into the underground water supply. All evidence indicates that the Canadian River to the north and the Pecos River to the west have cut off all of the underground flow from the Rocky Mountains. This ground water is of good quality for agricultural, municipal, and industrial uses, and its increased use, as yet, has not seriously depleted the supply. In many areas of range, this water, pumped into stock tanks by windmills, supplies the water for livestock.

Depth to the water table under the High Plains ranges from about 275 feet to about 350 feet. The water-bearing sand is as much as 400 feet thick (*8*).

Climate[2]

Gray County has a semiarid climate, and an average annual precipitation of 20.13 inches. Information about the temperature and precipitation is given in table 1.

Rainfall in this county occurs most frequently in the form of thunderstorms, and the amount of monthly and annual precipitation is extremely variable. Thundershowers are most frequent late in spring and early in summer. About 58 percent of the average annual pre-

[2] By ROBERT B. ORTON, State climatologist, U.S. Weather Bureau.

TABLE 1.—*Temperature and precipitation*

[All data from records kept at Pampa, Tex., elevation 3,230 feet, mainly for the 30-year period from 1932–1961]

Month	Temperature						Precipitation			
	Mean maximum	Mean minimum	Mean	Degree days[1]	Highest[2]	Lowest[2]	Average total	One year in 10 will have— Less than—	One year in 10 will have— More than—	Average depth of snow or sleet on days with snow or sleet cover
	°F.	°F.	°F.	°F.	°F.	°F.	Inches	Inches	Inches	Inches
January	47.6	22.4	35.0	868	81	−10	0.55	0.03	1.06	3.2
February	52.4	26.6	39.5	707	84	−10	.63	.09	1.26	2.7
March	59.4	31.3	45.4	633	92	−6	.80	.08	1.76	2.6
April	73.2	42.0	57.6	334	96	12	1.42	.21	2.47	.4
May	77.4	51.8	64.6	90	102	29	3.60	1.29	6.26	0
June	87.0	61.5	74.3	10	109	40	3.20	.97	5.66	0
July	91.0	65.6	78.3	(3)	108	53	2.43	.68	4.05	0
August	90.8	65.4	78.1	1	108	49	2.61	1.22	4.18	0
September	83.1	57.3	70.2	32	105	31	1.76	.16	3.42	0
October	72.6	46.8	59.7	209	95	26	1.93	.48	3.27	.4
November	59.2	32.1	45.7	615	86	6	.56	.01	1.88	.5
December	51.2	25.7	38.5	813	85	−1	.64	.04	.95	2.3
Year	70.4	44.0	57.2	4,313	109	−10	20.13	16.10	26.71	12.1

[1] Average period of record is 8 years. [2] Average period of record is 25 years. [3] Less than one-half degree day.

cipitation falls during the 4-month period from May to August, and about 84 percent falls during the growing season from April to October. Periods of 2 to 3 weeks, when no rain is received, are fairly common. Also, periods of a month or longer, when no measurable amount of rainfall is received, have been observed in all the months except June, July, and August.

The amount of monthly precipitation decreases greatly in the colder months of November through March because frequent "northers" cut off the supply of moisture from the Gulf of Mexico. In 1 year out of every 10 during any one of the winter months of November through March, less than 0.1 of an inch of rainfall is likely to be received.

The variability in the amount of rainfall is emphasized by the fact that a total annual amount of less than 16 inches is likely to be received 1 year out of 10, but a total amount of more than 26 inches is likely to be received during a similar period. The extremes in the annual amount of rainfall range from 10.25 inches, received in 1910, to 33.66 inches, received in 1941. The greatest amount recorded for any single day was 4.88 inches, received in July 1953. In extremely wet years, little benefit is derived from much of the precipitation. In wet years a large part of the rainfall is in the form of severe thundershowers, and much of the water is lost through runoff.

The average annual amount of snowfall is 12.1 inches, but the amount in a given season has been as little as a trace (in 1950) to as much as 30.5 inches (in 1931). Snow generally does not cover the ground evenly, because of the high winds. Also, it is likely to remain on the ground only 2 or 3 days, for the temperature generally rises after a snowstorm.

The county is subject to rapid and extreme changes in temperature, especially in winter and early in spring. During those periods, cold fronts from the northern Rocky Mountains and Plains States sweep across the Panhandle. These cold fronts move at speeds up to 40 miles per hour, and a drop in temperature of 50° to 60° within a 12-hour period is not uncommon.

January is the coldest month. The average temperature during that month is 35° F. The lowest recorded temperature of —10° has occurred in both January and February. Days in summer are hot, but good wind motion and low humidity lessen the discomfort from the high temperatures. Also, the high elevation allows rapid cooling after sundown.

In Gray County the average date of the last occurrence of a temperature of 32° or lower in spring is April 15, and the average date of the first occurrence of 32° or lower in fall is October 27. Thus, the length of the average freeze-free season is 200 days. There is a 20-percent chance that a temperature of 32° or lower will occur in spring after April 23 and earlier than October 17 in fall, and a 5-percent chance that a temperature of 32° or lower will occur after April 30 and earlier than October 10. The average number of days between the last occurrence of a temperature of 28° in spring and the first in fall is 215.

Winds are strongest during intense thunderstorms, or squalls, but these storms last for only a short time. The strongest continuous winds occur during March and April, when the prevailing direction of the winds is southwesterly. These winds sometimes produce severe duststorms early in spring.

Sunshine is abundant throughout the year. On the average, about 73 percent of the total amount possible is received. The relative humidity is low; it averages about 74 percent at 6:00 a.m. and about 44 percent at 6:00 p.m. The highest relative humidity generally occurs during the early morning hours in May through September, and the lowest occurs during the afternoon hours in March and April.

Severe windstorms or hailstorms may accompany severe thunderstorms, especially late in spring and early in summer. These storms usually form in the eastern part of New Mexico or in the western part of the Panhandle, and they advance across the area from the northwest, west, or southwest during the late afternoon or evening. Damage to crops may result from wind, hail, or excessive rainfall that accompany these storms. The peak of the thunderstorm activity corresponds rather closely to the maturing and harvesting periods for wheat. About 9 thunderstorms are to be expected during each of the months of May, June, and August, and about 11 are to be expected in July. Tornadoes are infrequent; only 8 are known to have touched ground in this county during the period from 1896 to 1961.

Evaporation is rather high, as would be expected in a semiarid climate. In this county the average annual amount of moisture evaporating from an "A"-type pan 4 feet in diameter is about 95 inches, according to records of the U.S. Weather Bureau. Approximately 68 percent of the average annual evaporation occurs during the growing season from May to October. The average annual evaporation from lakes is 65 inches (*3*).

General Soil Map

After studying the soils in a locality and the way they are arranged, it is possible to make a general map that shows several main patterns of soils, called soil associations. Such a map is the colored general soil map in the back of this report. As a rule, each association contains a few major soils and several minor soils in a pattern that is characteristic, although not strictly uniform.

The soils within any one association are likely to differ greatly among themselves in some properties; for example, slope, depth, stoniness, or natural drainage. Thus, the general map does not show the kind of soil at any particular place, but a pattern that has in it several kinds of soils.

The soil associations are named for the major soil series in them, but as already noted, soils of other series may also be present. The major soil series of one soil association may also be present in other associations, but in a different pattern.

The general map showing patterns of soils is useful to people who want a general idea of the soils, who want to compare different parts of a county, or who want to know the possible location of good-sized areas suitable for a certain kind of farming or other land use.

The five soil associations in Gray County are described in this section. More detailed information about the individual soils in each association can be obtained by studying the detailed soil map and by reading the section "Descriptions of the Soils."

1. Pullman Association

Nearly level to gently undulating hardlands of the High Plains

The soils of this association occupy nearly level to gently undulating areas on the High Plains in the western and northern parts of the county. The land surface slopes a few feet per mile to the east, and most of the runoff is impounded in scattered playa lakes. A small amount of runoff, near the edges of the plain, flows into steep-sided drainageways and canyons. These canyons drain into the Canadian River to the north and into the Red River to the south and east. The association occupies about 219,000 acres.

Fine-textured Pullman soils (fig. 2) make up about 80 percent of this association. These soils are continuous on the plain. They are nearly level and have a thin surface layer of clay loam and a subsoil of blocky clay.

A minor part of this association is made up of fine-textured Randall, Olton, Zita, Portales, Mansker, and Roscoe soils. The Randall soils are clayey. They are on the bottoms of playa lakes and are 2 to 30 feet lower than the Pullman soils. Olton and Zita soils are on low ridges and in shallow swales. They have a dark-colored surface layer and a clay loam subsoil. Portales soils are on low ridges, along drainageways, and around playa lakes. They have a surface layer and subsoil of calcareous clay loam. Mansker soils are in sloping areas around playa lakes or along the deeper drainageways. They have a friable, calcareous surface layer that is shallow over caliche. The clayey Roscoe soils occupy low lake benches in slightly higher areas than the Randall soils.

The soils of this association are fertile, and most of their acreage is cultivated. Wheat and grain sorghum are the main crops, but cotton, forage sorghum, and alfalfa are also grown. The size of the average farm is about 1,000 acres.

The susceptibility to wind erosion is slight. Water erosion is also only a minor hazard; it occurs where water concentrates in large, level or nearly level areas. The soils are well suited to flood and furrow irrigation, and the acreage of irrigated crops is increasing every year.

2. Mansker-Mobeetie Association

Rolling mixed land and breaks

This association occurs in a broad band along and just below the dissected margin of the nearly level High Plains. The areas are cut by deeply entrenched intermittent streams. Active geologic erosion is evident along the natural drains. Relief is mainly rolling but ranges from gently sloping to steep. The association occupies about 223,000 acres.

Mansker soils on ridges (fig. 3) make up about 40 percent of this association. These soils are fine textured to moderately coarse textured and have a dark-colored, calcareous surface layer over a friable, calcareous subsoil. Mobeetie soils are on foot slopes just below the Mansker soils, and they make up about 24 percent of this association. They are moderately coarse textured. They have a calcareous surface layer and a light-colored, friable subsoil.

A minor part of this association is made up of Rough broken land; Potter, Bippus, Spur, and Guadalupe soils; Hilly gravelly land; and Berthoud and Olton soils. Rough broken land occupies steep rough areas. The areas are on the steep sides of valleys and along canyons that are entrenched near the edge of the High Plains. Potter soils, which are very shallow over hard and soft caliche, are on ridges with the Mansker soils. They also occur with areas of hardened caliche caprock. Bippus, Spur, and Guadalupe soils are in the valleys. The Bippus soils have a thick, dark-colored surface layer and are in concave areas; the Spur and Guadalupe soils are dark colored, friable, and calcareous and are on bottom lands.

Hilly gravelly land is on gravelly knobs and ridges along streams. The Berthoud soils are on hillsides below the caprock at the edge of the High Plains. The Berthoud soils are deep and have a light-colored surface layer and a friable, calcareous subsoil. The Olton soils are on broad ridges and have a blocky clay loam subsoil.

Badland and Woodward, Quinlan, and Miles soils make up a small part of this association. Badland consists of steep, bare, eroded areas. The Woodward and Quinlan soils developed in material from red beds, which crop out along streams. Undulating areas of Miles soils occur on some of the low ridges above areas of Hilly gravelly land.

The soils of this association are well suited to native grasses and are used mainly for range. Short and mid grasses grow on the deep, fine-textured and medium-textured soils, and mid and tall grasses grow on the shallower soils and on the moderately coarse textured soils. Supplemental feed for livestock is grown in a few small fields. Most of the ranches within this association are several thousand acres in size.

In this association the soils are excessively drained and there is a large amount of runoff. The steep slopes, rough topography, and accelerated erosion are the main limitations to use of the soils.

3. Likes-Springer-Tivoli Association

Rolling sandy land and dunes

The soils of this association are moderately sloping and are cut by the entrenched channels of McClellan Creek, the North Fork Red River, and tributaries of those streams. The association is in the eastern and central parts of the county at a lower elevation than the other associations. Many intermittent streams and a few perennial streams flow through the shallow valleys and draws that are entrenched in the area. This association occupies about 96,000 acres.

Likes, Springer, and Tivoli (fig. 4) soils make up most of this association. Likes soils, on hillsides and in undulating areas, make up about 21 percent. These soils have a calcareous, sandy surface layer and subsoil. Springer soils, in hummocky areas, make up about 22 percent. They have a sandy surface layer and a moderately coarse textured subsoil. Tivoli soils, consisting of windblown fine sands, make up about 34 percent of the association. They occupy dunes or are on hillsides along or close to the North Fork Red River or the larger creeks.

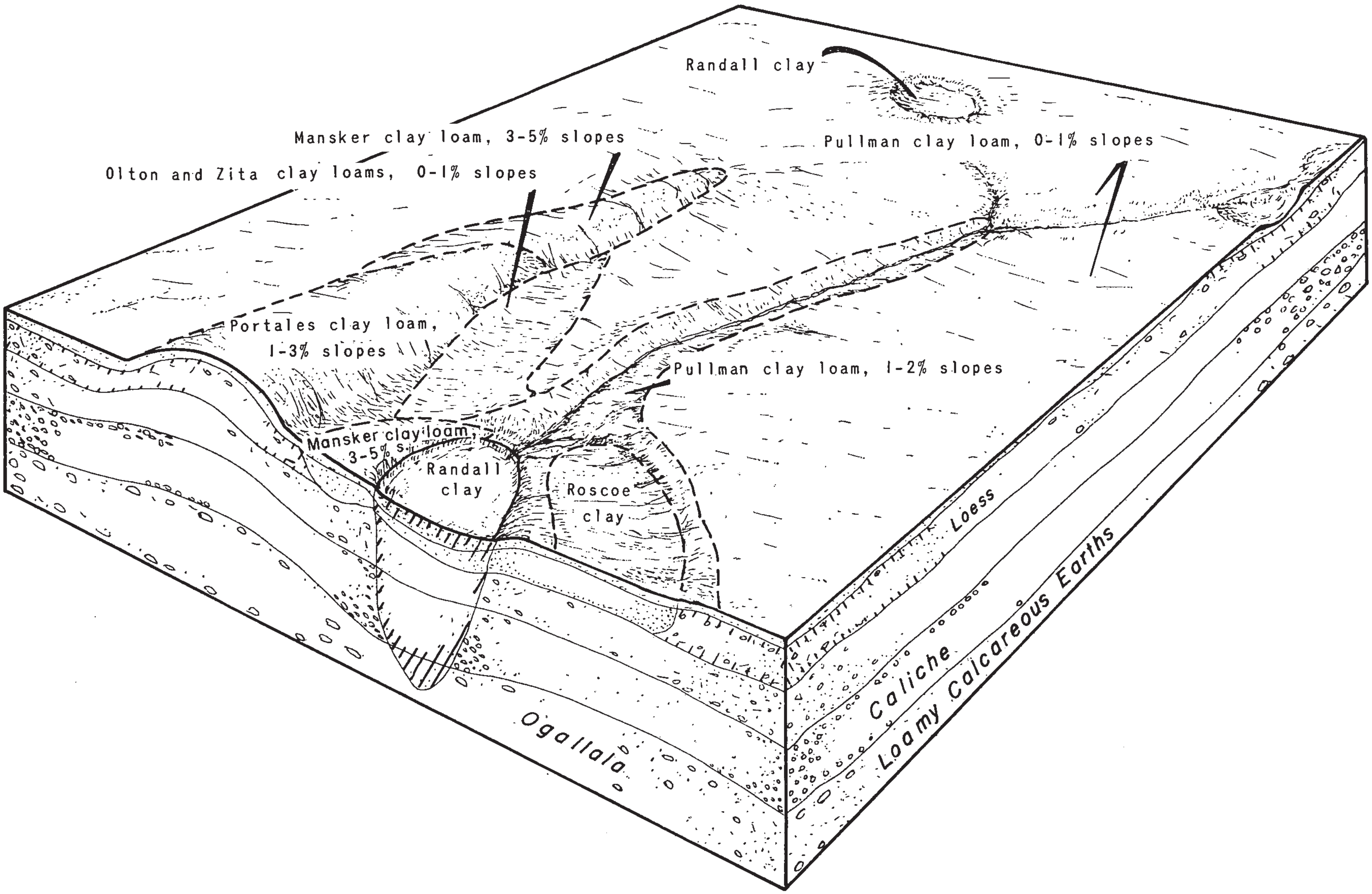

Figure 2.—Diagram showing the soils of association 1.

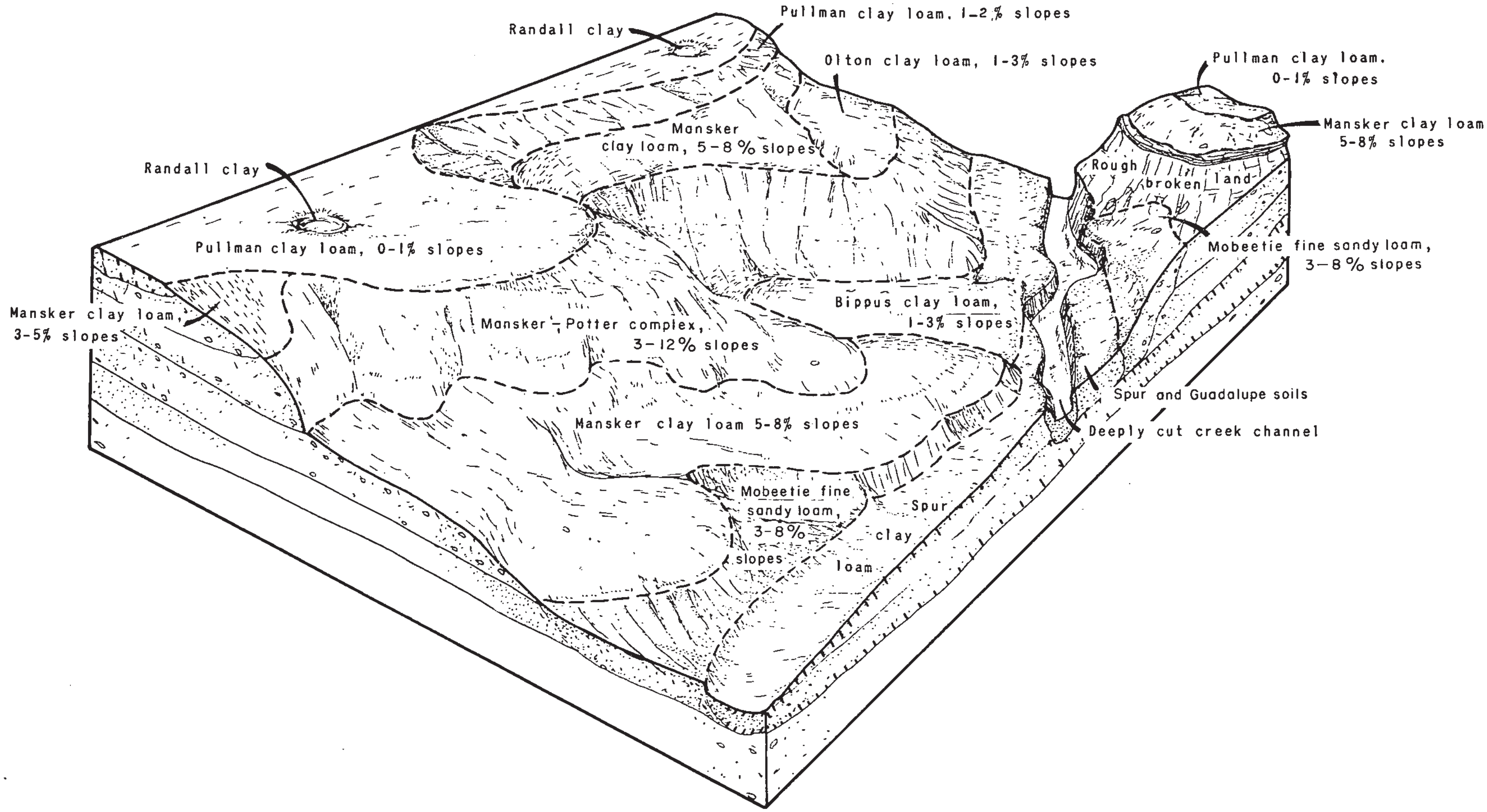

Figure 3.—Diagram showing the main soils of association 2, and also the main soils of association 1.

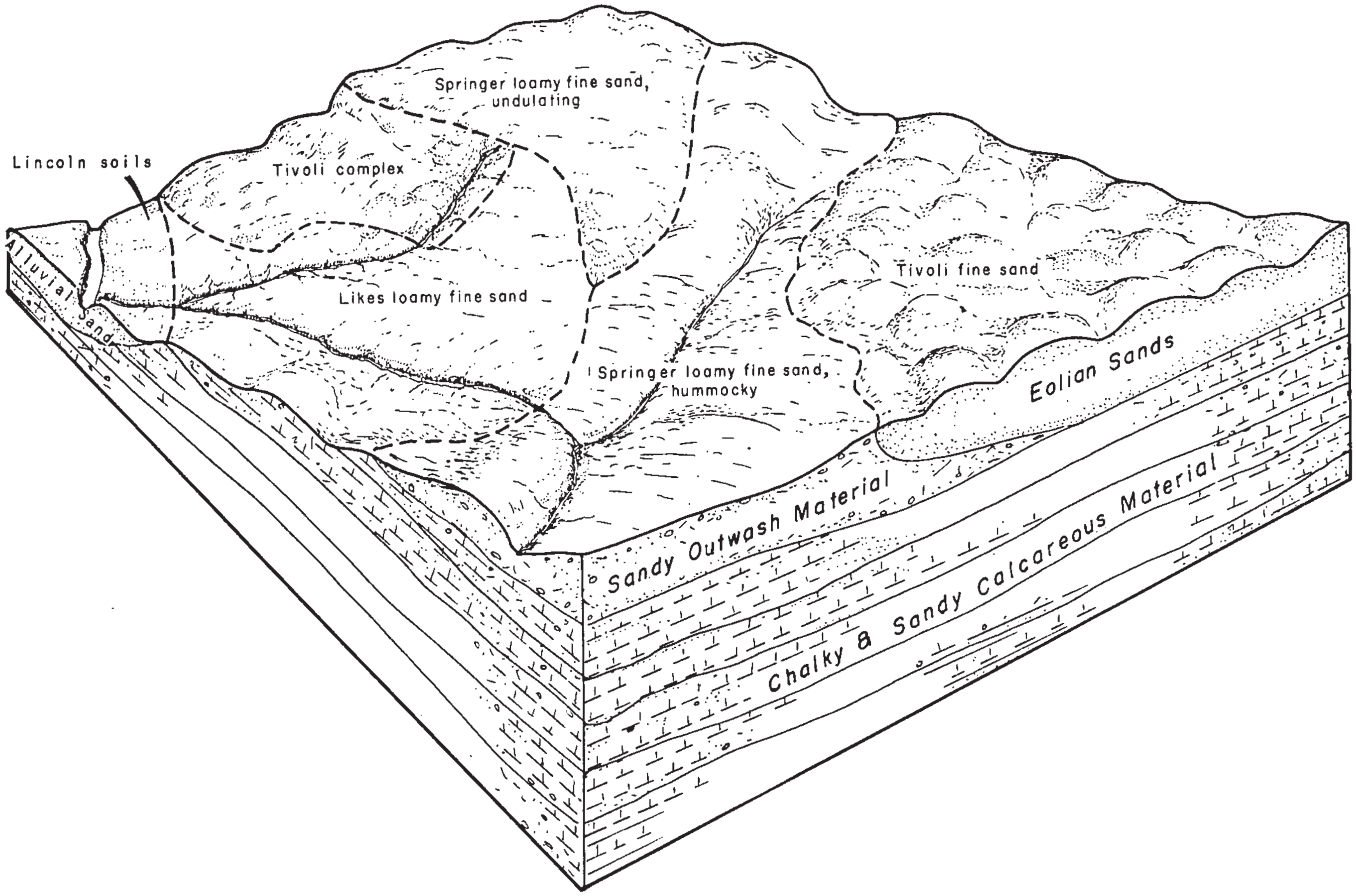

***Figure 4.*—Diagram showing the main soils of association 3.**

Minor soils of this association are the Miles, Lincoln, and Sweetwater. The Miles soils occur in hummocky areas with the Springer soils and in small undulating areas on ridges that finger into this association. They have a sandy surface layer and a moderately fine textured subsoil. The Lincoln and Sweetwater soils are on bottom lands. The Lincoln soils are light colored, sandy, and calcareous. The Sweetwater soils are dark colored and loamy, and they have a high water table.

The soils of this association are used for range, except where supplemental feed is grown in a few small fields on ridges or in valleys. Tall and mid grasses are dominant in the areas, but shin oak and sagebrush grow in some places. Most of the ranches are several thousand acres in size.

These soils are highly susceptible to wind erosion and are low in fertility. Control of woody plants is one of the major concerns of ranchers in this area.

4. Miles-Springer Association

Undulating sandy land

The soils of this association are mainly on the undulating plains in the southeastern part of the county near McLean. Elsewhere in the southeastern part of the county, a few areas are on broad ridges. This association has a poorly defined drainage pattern. The areas are at a higher elevation than those occupied by association 3, and they are broader and smoother than those occupied by association 5. The soils have a sandy surface layer and a friable loamy subsoil. The association occupies about 24,600 acres.

Coarse-textured Miles (fig. 5) soils make up about 75 percent of this association. They are on the undulating plains and are nearly level to moderately sloping. Springer soils make up about 23 percent. They are on low ridges within or along the edges of areas of Miles soils.

Minor soils of this association are the Mansker, Mobeetie, and Brownfield. The Mansker and Mobeetie soils are on low ridges within or along the edges of areas of Miles soils; they occupy positions a few feet higher than those occupied by the Miles soils. Brownfield soils occur with the Miles soils in moderately sloping, eroded areas. The association also includes a small acreage of moderately coarse textured Miles soils in concave areas.

Most of this association has been cultivated, and cotton and grain sorphum are the main crops. Wheat, barley, alfalfa, forage sorghum, and grass are also grown, and many fields that were formerly cultivated have been returned to grass. The size of farms within this association ranges from 200 to 1,000 acres.

The soils of this association are highly susceptible to wind erosion and are moderate to low in fertility. A few sprinkler irrigation systems have been installed.

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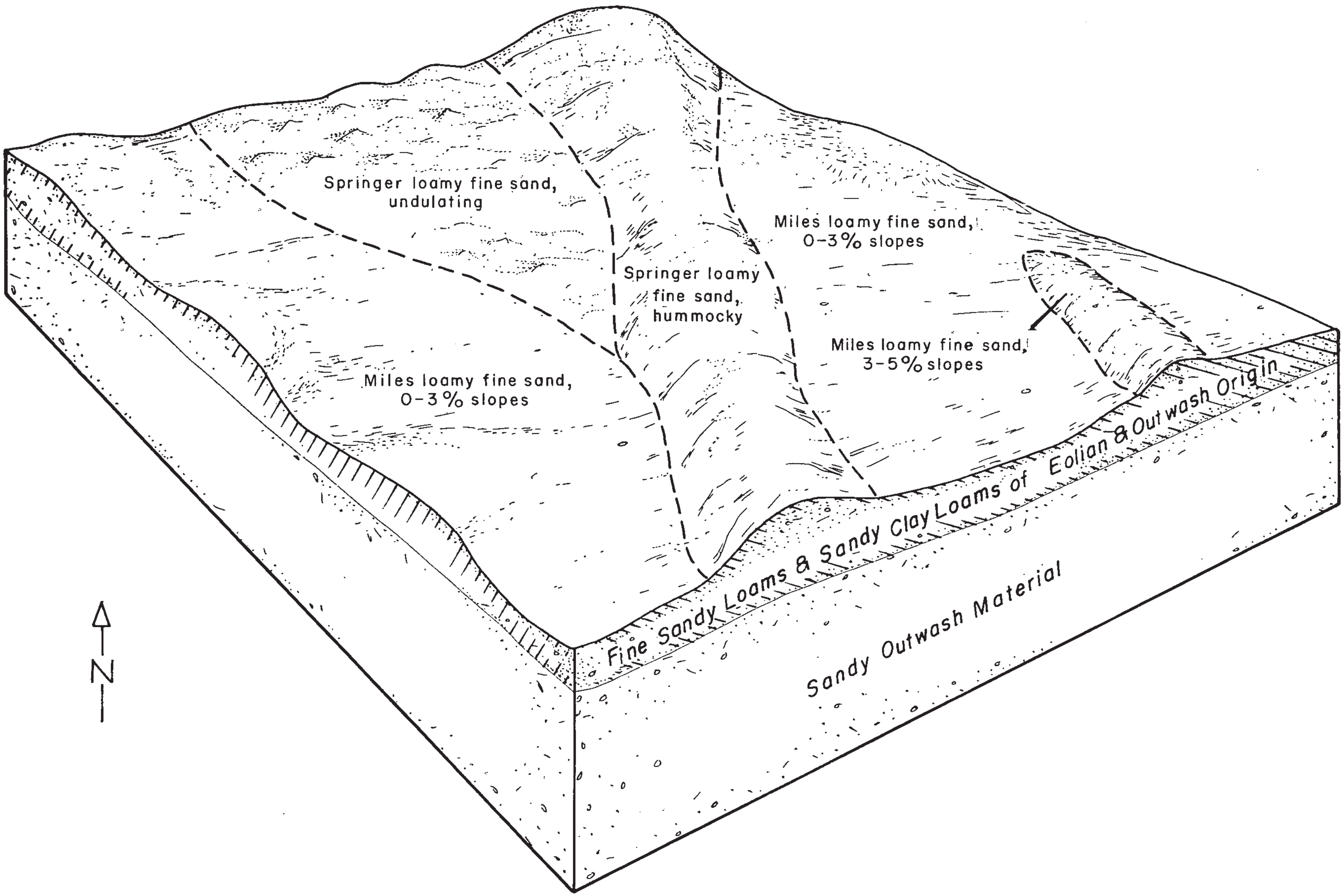

Figure 5.—**Diagram showing the main soils of association 4.**

5. Miles-Mobeetie Association

Undulating to rolling sandy loams

This association consists of undulating to rolling soils on broad ridges between the larger streams. The drainage pattern is moderately well defined. This association is in the eastern one-third of the county, and the largest areas are between McLean and Alanreed. The association occupies about 34,000 acres.

Moderately coarse textured Miles soils (fig. 6) make up about 85 percent of this association. They are on ridges and in broad, gently sloping areas above the Mobeetie soils. Their surface layer is loamy, and they have a friable, loamy subsoil. Mobeetie soils make up about 10 percent of this association. They occur with the Miles soils on low ridges and hillsides, and they have a calcareous, loamy surface layer and subsoil.

Soils of the Spur, Lincoln, Guadalupe, Bippus, and Mansker series make up a minor part of this association. These soils are in draws or on ridges.

The soils of this association are used for range and for cultivated crops, mainly cotton, grain sorghum, and forage sorghum. Most of the acreage on the larger farms is in range, and most of it on the smaller farms is in cultivated crops. The farms range from a few hundred to several thousand acres in size.

Wind erosion is a moderate hazard. Water erosion is also a hazard on the steeper slopes in cultivated fields. Scattered sagebrush and mesquite trees need to be controlled in some areas of this association.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Gray County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Miles and Pullman, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Miles fine sandy loam and Miles loamy fine sand are two soil types in the Miles series. The difference in texture of their surface layers is apparent from their names.

Some types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Pullman clay loam, 0 to 1 percent slopes, is one of several phases of Pullman clay loam, a soil type that ranges from nearly level to gently sloping.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodland, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Mansker-Potter complex, 3 to 12 percent slopes. Another kind of mapping unit is the undifferentiated group, which consists of two or more soils not separated on the map, because differences among them are small, their practical value is limited, or they are too difficult to reach. An example is Mansker and Mobeetie fine sandy loams, 1 to 3 percent slopes. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Hilly gravelly land or Rough broken land, and are called land types rather than soils.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same

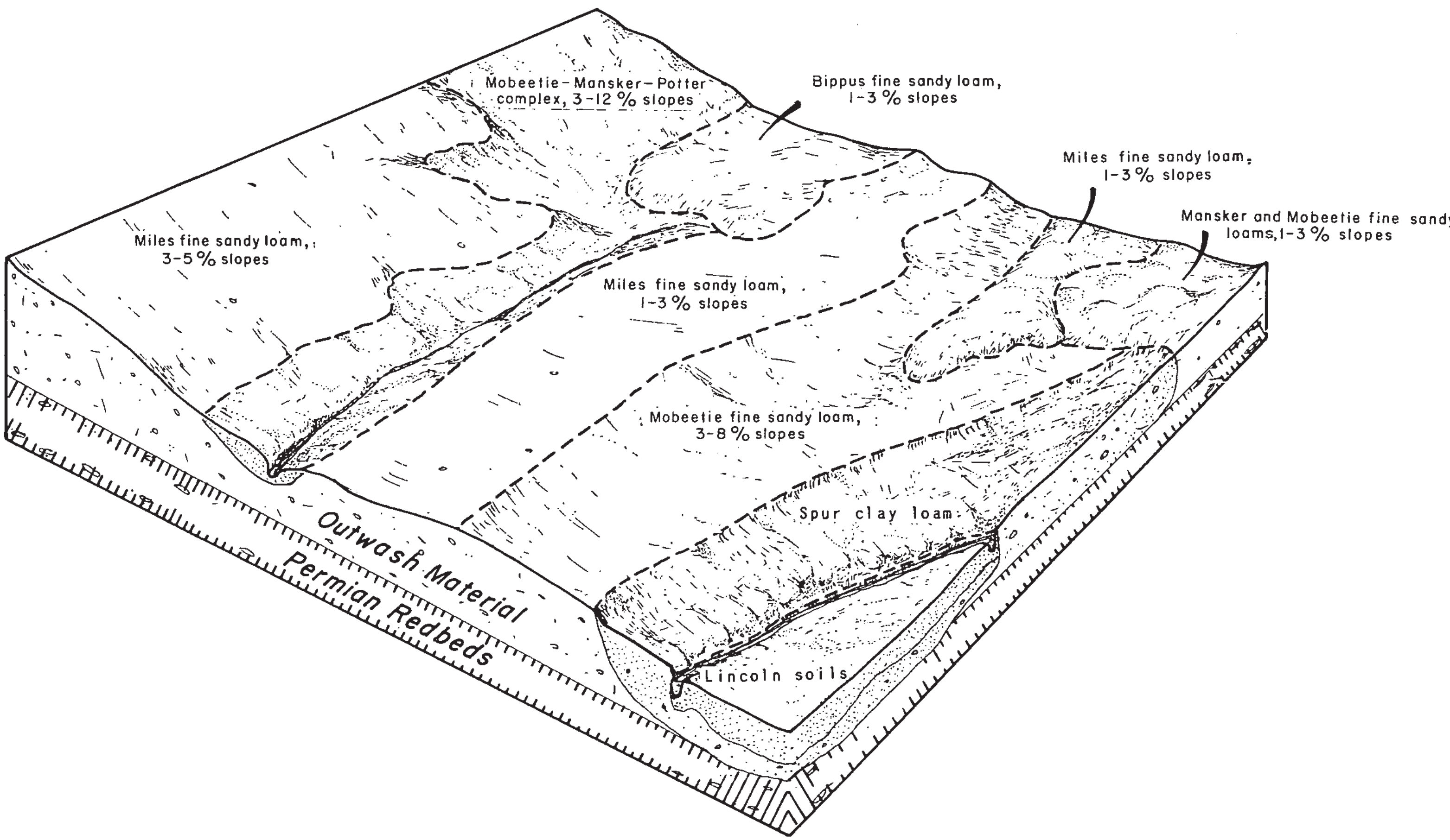

Figure 6.—**Diagram showing the main soils of association 5.**

kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey reports. On basis of the yield and practice tables and other data, the soil scientists set up trial groups, and then test the groups by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

Descriptions of the Soils

This section describes the soil series and the mapping units in Gray County. The procedure is first to describe each soil series, and then the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs.

The soil series contains a description of the soil profile, the major layers from the surface downward. This profile is considered typical, or representative, for all the soils of the series. If the profile for a given mapping unit differs from this typical profile, the differences are stated in the description of the mapping unit, or they are apparent in the name of the mapping unit. Some technical terms are used in describing soil series and mapping units, simply because there are no nontechnical terms that convey precisely the same meaning. Many of the more commonly used terms are defined in the Glossary.

The acreage and proportionate extent of the mapping units are shown in table 2. Detailed technical descriptions of soil series are given in the section "Formation, Classification, and Morphology of Soils." At the back of the report is a list of the mapping units in the county and the capability units and range site each is in. The page where each of these groups is described is also given.

TABLE 2.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent
Badland	2,690	0.4
Bippus clay loam, 1 to 3 percent slopes	3,750	.6
Bippus fine sandy loam, 1 to 3 percent slopes	5,030	.8
Hilly gravelly land	8,450	1.4
Likes loamy fine sand, 3 to 8 percent slopes	19,320	3.2
Lincoln soils	11,070	1.8
Mansker clay loam, 1 to 3 percent slopes	4,840	.8
Mansker clay loam, 3 to 5 percent slopes	25,930	4.3
Mansker clay loam, 5 to 8 percent slopes	24,780	4.1
Mansker and Mobeetie fine sandy loams, 1 to 3 percent slopes	790	.1
Mansker-Potter complex, 3 to 12 percent slopes	46,220	7.7
Miles fine sandy loam, 0 to 1 percent slopes	2,010	.3
Miles fine sandy loam, 1 to 3 percent slopes	13,070	2.2
Miles fine sandy loam, 3 to 5 percent slopes	12,340	2.1
Miles fine sandy loam, 3 to 5 percent slopes, eroded	1,510	.3
Miles loamy fine sand, 0 to 3 percent slopes	16,990	2.8
Miles loamy fine sand, 3 to 5 percent slopes	4,810	.8
Miles and Brownfield soils, 3 to 5 percent slopes, eroded	3,670	.6
Mobeetie fine sandy loam, 3 to 8 percent slopes	26,340	4.4
Mobeetie-Mansker-Potter complex, 3 to 12 percent slopes	40,150	6.7
Olton clay loam, 1 to 3 percent slopes	1,970	.3
Olton clay loam, 3 to 5 percent slopes	1,210	.2
Olton loam, 0 to 1 percent slopes	440	.1
Olton loam, 1 to 3 percent slopes	3,080	.5
Olton loam, 3 to 5 percent slopes	2,600	.4
Olton and Zita clay loams, 0 to 1 percent slopes	5,980	1.0
Olton and Zita clay loams, 1 to 3 percent slopes	4,080	.7
Portales clay loam, 0 to 1 percent slopes	1,400	.2
Portales clay loam, 1 to 3 percent slopes	6,100	1.0
Potter-Berthoud-Mansker complex, 5 to 20 percent slopes	26,890	4.4
Pullman clay loam, 0 to 1 percent slopes	153,570	25.5
Pullman clay loam, 1 to 2 percent slopes	19,130	3.1
Randall clay	12,470	2.1
Roscoe clay	3,390	.6
Rough broken land	13,180	2.2
Springer loamy fine sand, undulating	4,610	.8
Springer loamy fine sand, hummocky	22,380	3.7
Spur clay loam	3,510	.6
Spur and Guadalupe soils	2,840	.5
Sweetwater soils	2,370	.4
Tivoli fine sand	20,490	3.4
Tivoli complex	12,170	2.0
Woodward-Quinlan complex, 5 to 50 percent slopes	1,380	.2
Artificial lakes	230	(1)
City dumps	60	(1)
Gravel pits and borrow pits	130	(1)
Oil waste pits	50	(1)
River and creek channels	4,050	.7
Total	603,520	100.0

[1] Less than 0.05 percent.

Badland

Badland (Ba) consists mainly of steep, bare areas of loamy material cut by many channels and sharp divides (fig. 7). From the upper part of the escarpments to the bottom of the drainage channel, the slopes are 20 to 100 feet long. Some areas below the steep slopes are occupied by alluvial fans. Most of the water from rainfall runs off the steep areas, and during every rain, erosion is active. Erosion has cut into the friable, calcareous, loamy material of the Ogallala formation.

About 35 percent of this land type consists of inclusions of soils that have been classified and named. One of these included soils, Mobeetie fine sandy loam, makes up about 25 percent of most of the areas. It is on isolated buttes within the areas of Badland or in areas that resemble buttes that finger into the areas of Badland. Mansker clay loam and Potter soils occur at the top of the escarpments, along the upper edges of some areas. They make up about 10 percent of the acreage mapped as this land type. Likes loamy fine sand is also included. It occupies part of the alluvial fans or is on low, narrow dunes on one side of the areas. Each of the included areas is less than 5 acres in size.

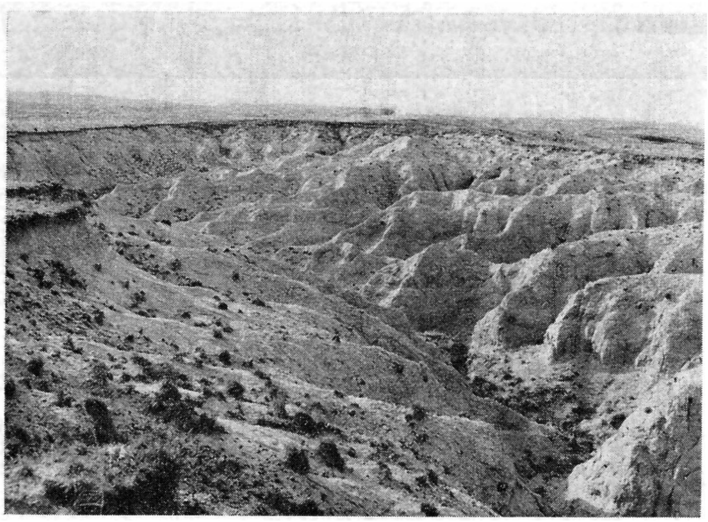

Figure 7.—**A typical area of Badland.**

Not enough grass is produced on the areas of Badland to control erosion. A small amount of grass grows on the raw sediments of the alluvial fans; the soil material on a few of the alluvial fans and in the broader drainageways has been partly stabilized by grass and brush. Blue grama, sideoats grama, and little bluestem grow on the included soils.

The severe damage from erosion makes the areas of Badland unsuitable for grazing, and this land type is best used for recreation, wildlife, or esthetic purposes. Also, the large amount of silt that washes from the areas must be considered when water facilities are planned downstream. Protecting the areas from livestock and encouraging the growth of plants help to stabilize this land type and reduce erosion. (Dryland capability unit VIIIe–2; not placed in an irrigated capability unit or range site)

Berthoud Series

The Berthoud series is made up of deep, calcareous, medium-textured soils of the uplands. These soils occupy sloping areas in the rolling and hilly parts of the county, below the edge of the caprock. They occur with the Potter and Mansker soils. The Berthoud soils developed under short and mid grasses.

The surface layer is grayish-brown to brown loam that is generally about 10 inches thick. It has granular structure and is hard when dry and friable when moist. Grass roots are abundant in this layer. The surface layer puddles easily if these soils are pastured when they are wet. As the puddled areas dry, a hard surface crust is formed that is difficult to break.

The subsoil is generally grayish-brown to very pale brown loam about 30 inches thick. It has weak prismatic and subangular blocky structure and is hard when dry and friable when moist. Permeability is moderate, and roots penetrate this layer easily. The subsoil has an accumulation of calcium carbonate in the lower part that is about 3 percent, by volume.

The substratum is calcareous, loamy alluvium washed down from the slopes above. It contains fragments of caliche.

The thickness of the surface layer ranges from 5 to 12 inches. The texture of the subsoil is fine sandy loam in a few places. Depth from the surface to the accumulation of calcium carbonate ranges from 16 to 30 inches, and the content of visible calcium carbonate ranges from 1 to 5 percent, by volume. A few fragments of limestone and a few quartz pebbles occur throughout the profile.

The Berthoud soils have a thinner, lighter colored surface layer and a less clayey subsoil than the Bippus soils. They are more sandy than the Mansker soils, and they contain a less prominent horizon where calcium carbonate has accumulated. They are slightly more clayey than the Mobeetie soils. The Berthoud soils are less reddish and contain coarser sand than the Woodward soils. Also, they developed in alluvium washed down from the slopes above rather than in sediments from the red beds. The Berthoud soils are more clayey than the Likes soils.

The Berthoud soils are well drained, and they take in water at a moderate rate. Much of the water runs off, however, before it soaks in. The soil material is rarely moist below a depth of 40 inches.

These Berthoud soils are used for range. They are mapped only in a complex with the Potter and Mansker soils.

Bippus Series

In the Bippus series are deep, dark-colored, moderately fine textured and moderately coarse textured soils of the uplands. These are gently sloping soils on foot slopes and fans in the rolling parts of the county below the edge of the High Plains.

The surface layer is very dark grayish-brown clay loam to fine sandy loam that is generally about 15 inches thick. This layer has granular, subangular blocky, or prismatic structure and is hard when dry and friable when moist.

In most places the subsoil is grayish-brown to very pale brown clay loam about 15 inches thick. It has weak prismatic and subangular blocky structure and is hard when dry and friable when moist. The subsoil is calcareous. It has an accumulation of calcium carbonate in the lower part that is visible but is less than 5 percent, by volume. The subsoil is moderately permeable and is readily penetrated by roots.

The substratum is calcareous alluvium washed down from the slopes above. A small amount of alluvial sediment continues to wash onto these soils.

The surface layer ranges from 10 to 24 inches in thickness, and that layer is calcareous in a few places. In a few places the texture of the subsoil is sandy clay loam. Depth to the layer where calcium carbonate has accumulated ranges from 20 to 50 inches, and the thickness of that layer ranges from 10 to 24 inches. In a few places the subsoil and the substratum contain buried layers of clay loam that has a blocky structure.

The Bippus soils have a thicker, darker colored surface layer and a more clayey subsoil than the Mobeetie soils. They are more brownish than the Olton and Miles soils, and the texture of their subsoil does not differ so distinctly from that of the surface layer.

These soils are used mostly for range, but some areas

are cultivated and a few are irrigated. Alfalfa, sorghum, cotton, and small grains are the main crops. These soils are fertile, and most areas receive runoff from soils in higher positions.

Bippus clay loam, 1 to 3 percent slopes (BcB).—This soil is on concave foot slopes at the edges of valleys or on alluvial fans on the valley floors in the central, southern, and eastern parts of the county. It lies just above the flood plains occupied by Spur clay loam. The areas are small, generally about 20 acres in size. Some scouring and deposition occur. Gullies are advancing up some drainageways, and stream channels are cutting into the lower edges of the areas in a few places.

Included with this soil in mapping are soils of other series or other Bippus soils that make up as much as 10 percent of some areas. Among the included soils are Spur clay loam on narrow flood plains along some drainageways and in the broader drainageways; areas of Bippus soils having a surface layer of loam, light silty clay loam, or fine sandy loam; and moderately sloping Bippus soils on the upper part of the slopes in some areas. Also included are areas of Mansker clay loam on low ridges, and of Olton clay loam. These included areas are less than 5 acres in size.

This Bippus soil is well suited to most crops grown in the area. Winter wheat and forage sorghum are the main crops, but alfalfa is grown in some irrigated areas. The native grasses are chiefly blue grama and buffalograss. The hazard of water erosion is moderate, and that of wind erosion is slight. (Dryland capability unit IIIe-2, irrigated capability unit IIe-2, Deep Hardland range site)

Bippus fine sandy loam, 1 to 3 percent slopes (BfB).—This soil is in gently sloping, concave areas on alluvial fans, foot slopes, and valley floors. The areas are small, and they are scattered throughout the central, southern, and eastern parts of the county.

The surface layer is fine sandy loam. The subsoil is generally clay loam, but it is sandy clay loam in a few places. In most places where this soil is in cultivated fields, it is slightly eroded. Gullies are advancing up some of the drainageways in the cultivated areas, and stream channels are cutting away the lower edges of a few areas.

Included in the areas mapped as this soil are other soils. Among these included soils are Spur and Guadalupe fine sandy loams in large drainageways, Mobeetie fine sandy loam on the upper edges of some areas of this Bippus soil, and Miles fine sandy loam near Alanreed and Lefors. Also included is soil material in meandering creek channels; soils in small depressions where the surface layer is loam or sandy clay loam; and on the upper edges of areas of this soil, patches of a Bippus fine sandy loam that has slopes of 3 to 4 percent. Each of these included areas is less than 5 acres in size.

This Bippus soil is well suited to all the crops grown in the county and is nearly as well suited to farming as Bippus clay loam, 1 to 3 percent slopes. The main dryland crops are cotton and grain sorghum; some alfalfa is grown under irrigation. The chief native grasses are blue grama, sideoats grama, and little bluestem. The hazard of wind erosion is moderate, but the hazard of water erosion is slight. Surface runoff is slow. (Dryland capability unit IIIe-4, irrigated capability unit IIe-5, Sandy Loam range site)

Brownfield Series

In the Brownfield series are deep, brownish, coarse-textured soils that are moderately sloping. These soils are on the uplands in the southeastern part of the county. They developed under a cover of tall and mid grasses and some brush.

In most places the surface layer is light-brown fine sand about 18 inches thick. It is structureless and is loose both when dry and when moist.

Generally the subsoil is reddish-brown sandy clay loam about 20 inches thick. It has moderate, very coarse, prismatic and weak, fine, subangular blocky structure. This layer is very hard when dry and friable when moist. It is moderately permeable and is easily penetrated by roots.

The substratum is moderately sandy outwash. It is reddish brown or yellowish red.

The thickness of the surface layer ranges from 4 to 24 inches. In areas that have been deep plowed, the surface layer is a mixture of fine sand and sandy clay loam. The thickness of the subsoil ranges from 12 to 30 inches.

The Brownfield soils have a more sandy surface layer than the Miles soils. Their subsoil is more clayey than that of the Springer, Likes, and Tivoli soils.

The Brownfield soils are easily eroded by wind and are low in fertility and in water-holding capacity. The sandy surface layer, steep slopes, and damage from past erosion limit their use. A thick stand of tall native grass is difficult to establish and maintain, and bare areas continue to blow and wash during windstorms and rainstorms.

In this county the Brownfield soils are mapped only in an undifferentiated unit with eroded Miles soils.

Guadalupe Series

In the Guadalupe series are dark-colored, calcareous, loamy soils. These soils are on the flood plains of most of the streams that drain the rolling and hilly areas below the High Plains. The native vegetation was tall, mid, and short grasses.

The surface layer is grayish-brown, dark grayish-brown, or brown fine sandy loam that has granular and subangular blocky structure. It is generally about 16 inches thick. This layer is hard when dry and very friable when moist. A small amount of fresh alluvium is added to it when these soils are flooded.

The subsoil is grayish-brown to pale-brown fine sandy loam that is generally about 20 inches thick. It has prismatic and subangular blocky structure and is very hard when dry and friable when moist. This layer is moderately permeable and is readily penetrated by roots.

The substratum consists of loamy calcareous sediments. This material washed from soils in upland watersheds.

The thickness of the surface layer ranges from 6 to 22 inches. The subsoil is 8 to 30 inches thick and contains thin layers of loam, clay loam, sandy clay loam, and loamy sand. Depth to the substratum ranges from 24 to 48 inches. The substratum contains thin layers of brownish sandy and loamy alluvial material. In a few places the water table is in the substratum.

The Guadalupe soils have a more sandy subsoil than the Spur soils. They are darker colored and more clayey than the Lincoln soils and are less grayish and better drained than the Sweetwater soils.

The Guadalupe soils are used mostly for range. They are easy to work, however, and some of the larger areas are cultivated. A few areas are irrigated. Yields of alfalfa, cotton, sorghum, and small grains are moderate to high. The hazard of wind erosion is moderate.

The Guadalupe soils are mapped only in an undifferentiated unit with the Spur soils.

Hilly Gravelly Land

Hilly gravelly land (Hg) is a miscellaneous land type in areas where there are many gravelly knobs and ridges. The areas have a pronounced drainage pattern. They are mainly on the edge of dissected terraces along the North Fork Red River east of Lefors and along McClellan Creek northeast of Alanreed.

The soil material in these areas varies in thickness, in content of gravel, and in other properties. The thickness over bedrock or red-bed material ranges from 3 inches to more than 40 inches. The content of gravel ranges from 10 percent to more than 50 percent. The slopes range from 3 to 20 percent.

Likes sandy loam makes up about 25 percent of the acreage mapped as this land type; Likes loamy fine sand, about 10 percent; and other soils and land types, about 20 percent. These included soils are intermingled with the soil material on the gravelly knobs and ridges, and they occupy areas less than 5 acres in size. Other inclusions are areas of caprock conglomerate that are several feet thick over red-bed material; areas of Woodward and Quinlan soils and of red-bed material; small areas of Mobeetie fine sandy loam, Miles fine sandy loam, and Springer loamy fine sand on ridges or on the higher parts of these areas; outcrops of loamy, calcareous soil material and weakly cemented sandstone; and Lincoln soils in the drainageways.

The different parts of areas of this land type support different kinds of plants. The main grasses on the gravelly knobs and ridges are sideoats grama, hairy grama, three-awn, and little bluestem. Scattered brushy plants are yucca and catclaw. The main grasses in the areas of Likes soils between the gravelly knobs and ridges are sand bluestem, little bluestem, indiangrass, switchgrass, sideoats grama, and blue grama. Brushy plants are sand sagebrush and skunkbush.

This land type is used mainly for range. It is moderately productive, but it needs good management for the control of erosion. The areas are also used by wildlife. Some areas are mined for sand and gravel, and mine pits and waste areas occur in some places. (Dryland capability unit VIs-1, not placed in an irrigated capability unit, Gravelly range site)

Likes Series

In the Likes series are deep, calcareous, coarse-textured soils that are gently sloping to sloping. These soils are in stream valleys in the uplands in the central and eastern parts of the county. They developed under tall and mid grasses and do not have well-defined horizons.

The surface layer is grayish-brown to yellowish-brown loamy fine sand that is generally about 10 inches thick. It has weak granular structure and is soft when dry and very friable when moist. The surface layer takes water readily and is easily penetrated by roots.

This subsoil is very pale brown to strong-brown fine sandy loam to fine sand that is generally about 24 inches thick. It has weak, subangular blocky structure and is soft when dry and very friable when moist. Permeability is moderately rapid in the subsoil. The capacity to hold water and plant nutrients is limited because of the coarse texture of the soil material.

The substratum is calcareous sandy outwash and loess, associated with the lower part of the Ogallala formation. It contains lenses of weakly cemented sandstone in some places.

The surface layer ranges from 8 to 18 inches in thickness. It is noncalcareous in a few places, and in a few places it has a texture of sandy loam. The thickness of the subsoil ranges from 12 to 36 inches. The content of gravel, sandstone, and hard caliche in the subsoil ranges from 0 to 20 percent, by volume. The texture of the substratum ranges from fine sandy loam to fine sand.

The Likes soils are more sandy than the Mobeetie soils. They are less reddish than the Miles and Springer soils, and the texture of their subsoil does not differ so distinctly from that of the surface layer. They are more loamy than the Tivoli soils.

These soils are used for range, and sand bluestem, indiangrass, switchgrass, little bluestem, and sideoats grama are the main grasses. Sand sagebrush, wild plum, yucca, skunkbush, and shin oak also grow in some areas.

These soils have low natural fertility. The sandy texture of the surface layer and the high content of calcium carbonate make the hazard of wind erosion serious, and blowing is likely in some bare areas.

Likes loamy fine sand, 3 to 8 percent slopes (LfD).—This is the only Likes soil mapped in the county. It is in shallow valleys and on hillsides along streams in the southeastern third of the county. Some areas are undulating and have a poorly defined pattern of surface drainage. Gully escarpments occur in some drainageways, and a few small blowout holes have formed in some areas.

Included with this soil in mapping are other soils that make up as much as 15 percent of some areas. Among these included soils are Springer loamy fine sand, Tivoli fine sand on small dunes, narrow areas of Lincoln soils in drainageways, Mansker fine sandy loam on ridges, and Mobeetie fine sandy loam on the lower hillsides in some areas. Each included area is less than 5 acres in size.

This Likes soil is good for range, but it is not suitable for crops. The hazard of wind erosion is severe, and the water-holding capacity is low in the sandy subsoil. The yields of grass can be increased by controlling brush (fig. 8) in these areas. (Dryland capability unit VIe-6, not placed in an irrigated capability unit, Sandyland range site)

Lincoln Series

The Lincoln series is made up of deep, light-colored, sandy, calcareous soils. These soils are on flood plains of most of the streams in the county. They developed under tall grasses.

Figure 8.—**An excellent stand of native grass on Likes loamy fine sand, 3 to 8 percent slopes. The brush has been controlled.**

These soils do not have well-defined horizons. In most places their surface layer is grayish-brown to pale-brown loamy fine sand about 12 inches thick. It has weak granular structure and is slightly hard when dry and very friable when moist. The content of organic matter is low, and the frequent floods add fresh alluvial sediments to this layer.

Below the surface layer is generally brownish-colored loamy sand that is several feet thick. This material is stratified and contains lenses of coarse sand, gravel, and loamy alluvial sediments. The loamy sand is structureless and is loose both when dry and when moist. It is rapidly permeable and can be easily penetrated by roots. The water table is at a depth of 2 to 10 feet in some areas. Mottling generally occurs below the water table. The material underlying the subsoil is calcareous sandy alluvial sediments.

The thickness of the surface layer ranges from 8 to 18 inches, and the texture ranges from fine sand to fine sandy loam. The surface layer is noncalcareous in a few places. In general, the texture of the material just below the surface layer is sand to loamy fine sand, but there are thin layers of fine sandy loam, very fine sandy loam, gravelly loam, or loam in places. Also, thin lenses of silt loam, clay loam, or silty clay loam, less than half an inch thick, occur in some areas of these soils.

The Lincoln soils are lighter colored and more sandy than the Spur and Guadalupe soils. They are better drained and have a lighter colored, more sandy surface layer than the Sweetwater soils.

The Lincoln soils are used mostly for range, but a few areas are in meadow. Tall grasses, a few cottonwood trees, and some sand sagebrush grow on most of the areas of range. Most areas of these soils are frequently to occasionally flooded, but a few areas are not flooded, because the stream channel is entrenched deeply enough to carry the floodwaters. The danger of floods and the severe hazard of wind erosion make these soils unsuitable for cultivation.

Lincoln soils (Ln).—These soils are on nearly level to undulating flood plains, only a few feet above the channel of the stream. They are on most of the bottom lands in the central and eastern parts of the county. In most places their profile is like the one described for the Lincoln series, but the texture of the surface layer is fine sand or fine sandy loam in many areas or parts of areas. Flooding of these soils causes scouring and stream cutting, and fresh alluvial material is deposited each time the areas are flooded. Meandering streams erode away the edges of some areas and add new material to others. Also, sediments from nearby stream channels are blown onto these soils.

Included in the areas mapped as these soils are narrow areas of Tivoli fine sand on low dunes; soil material in stream channels; and areas of Spur fine sandy loam, Guadalupe fine sandy loam, and Sweetwater soils. These included areas are less than 5 acres in size.

The Lincoln soils are good for grass. Sand bluestem, little bluestem, indiangrass, switchgrass, and sideoats grama are the main native grasses. The hazard of wind erosion is severe, and bare areas blow readily. Some areas are subirrigated. (Dryland capability unit Vw–2, not placed in an irrigated capability unit, Sandy Bottomland range site)

Mansker Series

In the Mansker series are dark-colored, moderately fine textured to moderately coarse-textured soils that have a weakly developed profile over loamy material. These soils are gently sloping to sloping and occur on uplands throughout the county. The largest areas are just below the edge of the nearly level High Plains, and they extend out from the High Plains for several miles.

The surface layer is brown to dark grayish-brown, calcareous clay loam to fine sandy loam that is about 8 inches thick in most places. This layer has granular structure and is slightly hard when dry and friable when moist. It is easily worked. The high content of calcium carbonate affects the growth of plants to some extent and increases the susceptibility of this soil to blowing.

Generally, the subsoil is grayish-brown to very pale brown clay loam that is strongly calcareous. It has moderate granular and subangular blocky structure and is hard when dry and friable when moist. Permeability is moderate, and roots penetrate the layer easily.

The substratum is loamy loess or alluvium that has a high content of lime. It contains a prominent layer where calcium carbonate has accumulated, generally at a depth of about 17 inches, but the depth ranges from 12 to 22 inches.

The surface layer ranges from 5 to 12 inches in thickness, and the texture is loam in some of the steeper areas. The texture of the subsoil is loam or sandy clay loam in a few places. The amount of visible calcium carbonate in the substratum ranges from 5 to 75 percent, by volume. In some places the substratum contains weakly cemented strata of caliche or sandstone.

The Mansker soils occur with the Potter soils (fig. 9), but their profile is thicker than that of the Potter soils. The Mansker soils are shallower over a conspicuous layer where calcium carbonate has accumulated than are the Portales soils. They have a calcareous and thinner surface layer and a less well developed profile than the Zita soils. The Mansker soils are more clayey than the Berthoud and Mobeetie soils.

Figure 9.—**An area of Mansker clay loam, 5 to 8 percent slopes, in range. Mansker-Potter complex, 3 to 12 percent slopes, is in the background.**

Some of the gently sloping and moderately sloping areas of these soils are cultivated. Winter wheat and forage sorghum are the chief crops.

These soils are well drained. Their thin profile limits their capacity to hold plant nutrients and water.

Mansker clay loam, 1 to 3 percent slopes (MaB).—This soil is around playa lakes, along drainageways, and on low ridges on the High Plains. In the areas below the edge of the High Plains, it is on ridges and on gently sloping hillsides. The surface layer is slightly darker than that of the other Mansker clay loams. The layer where calcium carbonate has accumulated contains more calcium carbonate than the comparable layer in the other Mansker clay loams. The soil material in the uppermost 8 inches of the profile is noncalcareous in a few places. Erosion by wind and water has removed a few inches of the surface layer in most cultivated fields. Where the slopes are 2 to 3 percent, a few shallow rills develop after a heavy rain.

Portales, Olton, and Zita soils in low places and Potter soils on ridges make up as much as 10 percent of any area mapped as this Mansker soil. Each of the areas of included soils is less than 5 acres in size.

This Mansker soil is fairly good for crops and is good for grass. About one-fourth of the acreage is cultivated. The chief crops are small grains and sorghum, and yields are moderate to low. The main native grasses are blue grama, sideoats grama, and little bluestem. Some cropland has been abandoned or reseeded to grass. The hazard of wind erosion is slight, and the hazard of water erosion is slight to moderate. (Dryland capability unit IIIe-7, irrigated capability unit IIIe-7, Hardland Slopes range site)

Mansker clay loam, 3 to 5 percent slopes (MaC).—This soil lies around playa lakes and along drainageways in areas of the High Plains. It is below the edge of the High Plains on ridges and hillsides. In a few places the texture of the surface layer is loam. The horizon where calcium carbonate has accumulated is less conspicuous (fig. 10) than that in Mansker clay loam, 1 to 3 percent slopes. In fields that are now cultivated or that have been cultivated, this soil is generally slightly to moderately eroded. Erosion by wind and water has removed as

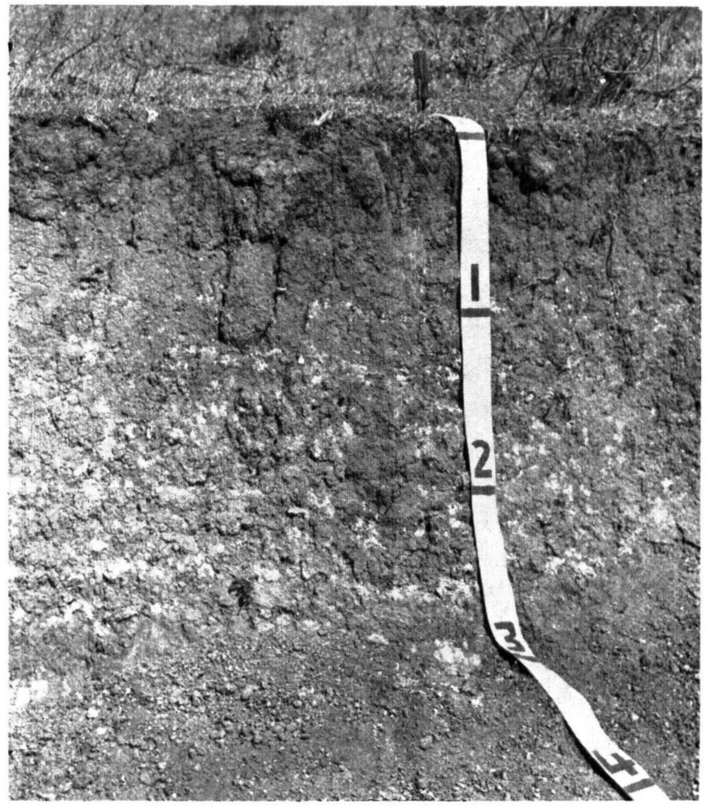

Figure 10.—**Profile of Mansker clay loam, 3 to 5 percent slopes, showing where calcium carbonate has accumulated.**

much as half of the original surface layer, and shallow gullies occur in some of the drainageways. In areas of range, escarpments, or abrupt rises, as much as 3 feet high are in and on the sides of a few natural drainageways.

As much as 15 percent of most areas mapped as this soil consist of inclusions of other soils. Among these included soils are Portales clay loam, Berthoud loam on the lower slopes, Olton clay loam in narrow areas along ridges, Mansker fine sandy loam near Alanreed, Potter soils, and small areas of gently sloping and moderately sloping other soils. Also included are areas of Bippus and Spur clay loams in drainageways in the larger areas of this Mansker soil, and eroded areas in a few fields. Each of the included areas is less than 5 acres in size.

This Mansker soil absorbs some moisture from rainfall, but some of the rainfall runs off before it can soak in. The hazard of wind erosion is slight, and the hazard of water erosion is moderate.

This soil is good for grass, but it is fair to poor for most crops. It is used mostly for range, and blue grama, sideoats grama, and little bluestem are the chief grasses. Winter wheat, grain sorghum, and forage sorghum are grown on a small acreage each year. (Dryland capability unit IVe-2, not placed in an irrigated capability unit, Hardland Slopes range site)

Mansker clay loam, 5 to 8 percent slopes (MaD).—This soil is along ridges, on hillsides, and in drainageways in valleys. Large tracts are in the steeper areas below the edge of the nearly level High Plains. The texture of the surface layer and subsoil is loam instead of clay loam in a few places. The horizon where calcium carbonate has

accumulated is less conspicuous than that in the less sloping Mansker clay loams. Advancing scarps, generally 2 to 3 feet high but in some places as much as 8 feet high, are on both sides of many of the drainageways. In some places the scarps have advanced as much as 75 feet up the hillsides. Most of the areas in the drainageways between these scarps have revegetated and are stabilized. In a few places two or three of these scarps are advancing up the sides of a drainageway. They occur in benches that resemble steps. These scarps indicate the progress of gradual erosion into the High Plains; they appear to be advancing a few feet each decade.

Included with this soil in mapping are other soils that make up about 15 percent of most areas. Among these included soils are Bippus clay loam in drainageways, Olton clay loam on ridges, and Potter soils on ridges and knolls. A few areas of moderately sloping soils are also included. Each of these included areas is less than 5 acres in size.

The hazard of wind erosion is slight on this Mansker soil, but the hazard of water erosion is severe. Water runs off before it can soak in, and this soil is rarely moist below a depth of 3 feet.

This soil is good for grass, and most of the areas are in range. Blue grama, buffalograss, and sideoats grama are the chief grasses. Scattered yucca and catclaw grow in some areas. (Dryland capability unit VIe–2, not placed in an irrigated capability unit, Hardland Slopes range site)

Mansker and Mobeetie fine sandy loams, 1 to 3 percent slopes (MbB).—This undifferentiated unit is made up of about 60 percent Mansker fine sandy loam and about 40 percent Mobeetie fine sandy loam. Individual areas, however, may be Mansker soil, Mobeetie soil, or both. These soils occur mainly in small areas with the Miles soils and are scattered throughout the southeastern part of the county. The Mansker soil has a subsoil of sandy clay loam. In some places the substratum contains weakly cemented, calcareous sandstone; otherwise, it is like the substratum in the profile described for the Mansker series. The profile of the Mobeetie soil is like the one described for the Mobeetie series. Most areas that have been cultivated are slightly eroded.

Included with these soils in mapping are other soils that make up about 15 percent of some areas. Among the included soils are Miles fine sandy loam and Miles loamy fine sand in low areas, small areas of Potter soils on ridges and knobs, and a few areas, about 1 acre in size, of gravelly soil material on knobs. Each included area is less than 5 acres in size.

The soils of this undifferentiated unit are calcareous, have low water-holding capacity, and are low in fertility. Also, they are subject to erosion by wind and water.

Only a small acreage is cultivated. The yields of most crops are low, and many areas that were formerly cultivated have been returned to grass. The chief crops are grain sorghum and forage sorghum. A small acreage of these soils, in large fields with other soils, has been irrigated. Where cultivated crops are grown, stubble-mulch farming, terracing, and contour farming are needed to control erosion and to conserve moisture. Also, fertilizer is needed to maintain fertility. (Dryland capability unit IVe–10, irrigated capability unit IIIe–7, Mixedland Slopes range site)

Mansker-Potter complex, 3 to 12 percent slopes (McD).—About 75 percent of this complex is Mansker clay loam, 15 percent is Potter soils, and 10 percent is other soils, but the proportions of each soil vary widely in different parts of the county. These soils were mapped in a complex because it was impractical to separate them on the map. They are extensive along the areas of the dissected margin of the High Plains. The Mansker soil is moderately sloping to strongly sloping and is on hillsides, knobs, and ridges. The Potter soils are sloping to moderately steep and are also on knobs and ridges. They generally have a texture of loam or gravelly loam. A typical profile of a Mansker soil is described under the Mansker series, and a typical profile of a Potter soil is described under the Potter series.

Although the proportion of other soils included in this complex is generally about 10 percent, it ranges from 5 to 30 percent. Among the inclusions are ledges of hard caliche caprock and areas of Rough broken land on escarpments and in areas of subdued escarpments, areas of Mobeetie fine sandy loam on hillsides, and areas of Bippus clay loam and Spur clay loam along drainageways. Also included are small areas of Badland and of gullies and advancing escarpments in drainageways.

The soils of this complex are well suited to grass and are used for range. The different soils, however, support different kinds of vegetation. The main grasses on the Mansker soil are blue grama, sideoats grama, and some scattered little bluestem. The main grasses on the Potter soils are little bluestem, sideoats grama, hairy grama, blue grama, three-awn, and catclaw. Because the soils that make up this complex vary, it is difficult to manage and use the areas for the maximum production of grass. More information on the use of these soils for range is given in the section "Use of the Soils for Range." (Mansker soil is in dryland capability unit VIe–2 and Hardland Slopes range site, and Potter soils are in dryland capability unit VIIs–1 and Very Shallow range site; these soils have not been placed in an irrigated capability unit)

Miles Series

The Miles series is made up of deep, brownish, moderately coarse textured and coarse textured soils that are nearly level to moderately sloping. These soils are on uplands in the central and eastern parts of the county. They developed under tall, mid, and short grasses.

The surface layer is brown to dark-brown fine sandy loam to loamy fine sand that is generally about 10 inches thick. It has granular and subangular blocky structure, is soft to slightly hard when dry, and is very friable when moist. The soil material in this layer is easily worked, but it is easily eroded by wind. A compaction pan is likely to form if these soils are plowed when they are wet.

The subsoil is generally dark reddish-brown to yellowish-red sandy clay loam about 30 inches thick. It has moderate, coarse, prismatic and weak, medium and fine, subangular blocky structure. The subsoil is very hard when dry and friable when moist, and it is moderately permeable. The lower part is lighter colored and more sandy than the upper part. Roots penetrate this layer easily.

The substratum is moderately sandy outwash that is many feet thick around McLean. To the west, toward

the edge of the High Plains, the layer of outwash thins. In some places there, it is only 2 feet thick over caliche of the Ogallala formation.

The thickness of the surface layer ranges from 4 to 22 inches. Where the texture is fine sandy loam, the surface layer is 4 to 16 inches thick. Where the texture is loamy fine sand, the surface layer is 7 to 22 inches thick. In some nearly level areas, the surface layer has a dark grayish-brown color. In a few places the texture of the subsoil is heavy fine sandy loam or light clay loam. Some areas contain a weakly defined horizon where calcium carbonate has accumulated. The more sloping Miles soils generally have a thinner, less clayey subsoil than the gently sloping Miles soils. A few quartz pebbles occur throughout the profile in some areas.

The Miles soils have a more clayey subsoil than the Springer soils and a more loamy surface layer than the Brownfield soils. They are more clayey and more reddish than the Likes soils, and they are not calcareous like those soils. The Miles soils have a more friable subsoil and are more sandy throughout than the Olton soils. They are more reddish and have a thinner surface layer than the Bippus soils, and they have a better developed subsoil.

The Miles soils are moderately fertile and are well suited to cotton, alfalfa, small grains, sorghum, and grass. Many of the nearly level and gently sloping areas are cultivated. Cotton and grain sorghum are the principal dryland crops, and alfalfa and improved grasses are the main irrigated crops.

Miles fine sandy loam, 0 to 1 percent slopes (MfA).—This soil is mainly in small, scattered areas in the central and eastern parts of the county. It is on broad ridges with gently sloping areas of Miles fine sandy loam. In a few places it is in depressions within large areas of Miles loamy fine sand. The surface layer is less reddish than that of the other Miles fine sandy loams in this county; it is dark grayish brown in some places. The surface layer is generally about 10 inches thick, and the subsoil is 15 to 48 inches thick. In most cultivated fields, wind erosion has removed a few inches of the surface layer.

Other soils make up as much as 10 percent of most areas mapped as this soil. Among these included soils are two areas of Altus fine sandy loam in drainageways south and southeast of McLean, patches of gently sloping Miles loamy fine sand and Miles fine sandy loam on ridges within or at the edge of the mapped areas of this soil, and a few low areas where the surface layer is loam. All but the included areas of Altus fine sandy loam are less than 5 acres in size. The Altus soils are not mapped separately in this county.

Most areas of this Miles soil receive extra water from other soils and are well suited to crops and grass. About half of the acreage is cultivated, and cotton, grain sorghum, and pasture are the chief crops. The main native grasses on the areas in range are blue grama, buffalograss, and little bluestem. Brushy plants are scattered sand sagebrush and mesquite trees. (Dryland capability unit IIIe–4, irrigated capability unit IIe–4, Sandy Loam range site)

Miles fine sandy loam, 1 to 3 percent slopes (MfB).—This soil is on broad ridges that slope mostly to the south and east and are in the southern, central, and eastern parts of the county. The areas are scattered and are generally about 40 acres in size. The surface layer is brown and ranges from 4 to 12 inches in thickness. The subsoil is reddish-brown to brown and has a texture of heavy fine sandy loam to light clay loam.

In most cultivated areas the surface layer has been thinned a few inches by wind and water erosion. Wind has winnowed the surface layer and left lenses of loamy fine sand. In areas that have slopes of 2 to 3 percent, small rills and washes appear after every heavy rain. In cultivated areas part of the subsoil has been mixed into the surface layer. Some of the areas have been deep plowed.

As much as 10 percent of some areas mapped as this soil consists of other soils. These included soils are small, nearly level areas of Miles fine sandy loam; moderately sloping areas of Miles fine sandy loam on small ridges within and at the edge of the areas mapped as this soil; areas of soils that have a surface layer of loamy fine sand, loam, or sandy clay loam; and small areas, less than 1 acre in size, of gravelly soil material on knobs and outcrops of caliche. Eroded areas and areas of Mansker clay loam and Mansker fine sandy loam on low ridges are also included. Each of the included areas is less than 5 acres in size.

This Miles soil is well suited to cotton, grain sorghum, forage sorghum, small grains, and grass. About half of the acreage is cultivated, and cotton and grain sorghum are the chief dryland crops. The hazard of wind erosion is moderate, and the hazard of water erosion is slight. Blue grama, buffalograss, and little bluestem are the main native grasses in the areas in range. Brushy plants are scattered sand sagebrush and mesquite trees. (Dryland capability unit IIIe–4, irrigated capability unit IIe–5, Sandy Loam range site)

Miles fine sandy loam, 3 to 5 percent slopes (MfC).—This soil is on hillsides and ridges that are scattered throughout the rolling areas east of the High Plains. The areas are generally about 35 acres in size. The surface layer is about 5 inches thick. The subsoil is slightly thinner and slightly more sandy than that of the less sloping Miles fine sandy loams. Most of the cultivated areas are slightly eroded; erosion by wind and water has removed a few inches of the surface layer. In about one-tenth of the acreage, the original surface layer has been completely removed. There are a few rills and shallow gullies.

About 10 percent of some areas mapped as this Miles soil are Mansker clay loam, Olton loam, Miles loamy fine sand, gently sloping areas of Miles fine sandy loam, and Springer loamy fine sand. Small areas, less than 1 acre in size, of gravelly soil material on knobs and ridges and outcrops of caliche are also included in some places. Each of the included areas is less than 5 acres in size.

This Miles soil is good for range, but it is marginal for crops. About one-fourth of the acreage, however, is in cultivated crops, mainly grain sorghum, forage sorghum, and small grains. The hazard of erosion by wind and water is moderate. Although surface runoff is greater than on the gently sloping Miles soils, it is still medium. (Dryland capability unit IVe–4, irrigated capability unit IIIe–3, Sandy Loam range site)

Miles fine sandy loam, 3 to 5 percent slopes, eroded (MfC2).—This eroded soil occurs in small areas that are now cultivated or that have been cultivated. The

damage caused by wind and water erosion in these areas is evident. About one-fourth of the acreage is slightly eroded. In about one-sixth of the acreage, all of the original surface layer has been lost through erosion, and in about one-half of the acreage, most of the original surface layer has been lost. Washes and gullies that have cut into the subsoil occur about every 80 feet on the slopes. About one out of every four of these washes or gullies is too deep to cross with farm equipment. Sand, as much as 2 feet deep, has accumulated in natural drainageways at the foot of the slopes. The sand is as much as a foot deep along fence rows.

Included with this soil in mapping are a few areas of Miles fine sandy loam that has slopes of only 2 to 3 percent.

This eroded Miles soil is fair for range, but it is marginal for crops. Small areas are in range, and many of the areas that were formerly cultivated have been returned to grass. Yields are limited as the result of past erosion and the loss of water through runoff. This soil can be greatly improved for crops if erosion is controlled by installing a system of terraces and if other practices are used that conserve water and provide protection. (Dryland capability unit IVe-4, not placed in an irrigated capability unit, Sandy Loam range site)

Miles loamy fine sand, 0 to 3 percent slopes (MdB).—This soil is in undulating areas in the southeastern part of the county. The areas range from only a few acres to several thousand acres in size. The surface layer is about 12 inches thick and is slightly lighter in color than that of the Miles fine sandy loams. Some areas have been deep plowed, and part of the subsoil in those areas has been mixed into the surface layer. In cultivated fields the soil material in the surface layer has been winnowed by wind. In a few places, the wind has blown away the finer particles and the present surface layer is fine sand. Small spots in some fields have had all of the surface layer removed by wind erosion, and the bare subsoil is exposed. Sand has accumulated along the boundaries of most fields. The accumulations of sand are 10 to 30 feet wide and are as much as 3 feet deep. A few shallow washes or gullies occur on the steeper slopes.

Included with this soil in mapping are areas of Springer loamy fine sand in narrow bands or on knolls, Altus loamy fine sand in small concave areas, moderately sloping areas of Miles loamy fine sand on narrow ridges, small areas of Miles fine sandy loam, and a few small areas of Mansker fine sandy loam on knolls. Also included are areas of Brownfield fine sand along the Wheeler County line in the southeastern part of the county, gravelly soil material on knobs, outcrops of caliche, and a few severely eroded areas as much as 3 acres in size. Each of these included areas is less than 5 acres in size.

Most of the rainfall soaks into this Miles soil. The drainage pattern in large areas of this soil is poorly defined. This Miles soil is good for range. It is only fair for crops because the hazard of wind erosion is severe. About one-third of the acreage is cultivated, and cotton, sorghum, small grains, and grass are the chief crops. Some alfalfa and grass are grown under sprinkler irrigation. Careful management is required to protect this soil from excessive blowing. (Dryland capability unit IVe-6, irrigated capability unit IIIe-6, Sandyland range site)

Miles loamy fine sand, 3 to 5 percent slopes (MdC).—This soil is on hillsides and ridges that are scattered throughout the sandy, rolling hills in the southeastern part of the county. The areas are about 60 acres in size. The surface layer is generally 3 to 4 inches thinner than that of Miles loamy fine sand, 0 to 3 percent slopes. The subsoil is sandy clay loam and is a few inches thinner and contains slightly less clay than the subsoil in the profile described for the Miles series. In cultivated fields the surface layer has been thinned by wind and water erosion. A few shallow washes have developed, and these cut into the subsoil. Deep gullies occur in a few drainageways in old fields and in areas of range.

About 15 percent of most areas mapped as this soil consists of small, gently sloping areas of Miles loamy fine sand on ridges, Springer loamy fine sand, Miles fine sandy loam on ridges and knobs, Mansker fine sandy loams, and Likes loamy fine sand. A few small areas of eroded Springer, Miles, and Brownfield soils in old cultivated fields are also included. Each of these included areas is less than 5 acres in size.

Surface runoff is slow on this Miles soil, and most of the water soaks in. This soil is good for grass, and most of the acreage is used for range. Most of the cultivated fields have been returned to grass, and only a few are still cultivated. The chief grasses are sand bluestem, little bluestem, switchgrass, indiangrass, sideoats grama, and blue grama. Woody plants that grow on most of the areas are sand sagebrush and shin oak; taller shin oaks grow in small scattered bunches. Sprinkler irrigation can be used on this soil if practices are used that control erosion. (Dryland capability unit VIe-6, irrigated capability unit IVe-2, Sandyland range site)

Miles and Brownfield soils, 3 to 5 percent slopes, eroded (MhC2).—This undifferentiated unit occurs in eroded, hummocky areas. In some places all of an area is Miles loamy fine sand. In other places all of it is Brownfield fine sand, and in still other places both soils occur. Of the total acreage, about 55 percent is Miles soil and 45 percent is Brownfield soil. Erosion has so altered the original surface layer that the texture is now fine sand, sandy clay loam, or fine sandy loam. The Miles soil has a profile like the one described for the Miles series. A profile of the Brownfield soil is described under the Brownfield series.

Nearly all of the acreage has been cultivated, and the damage from erosion is evident. In most places more than half of the surface layer has been blown away or has washed away. All of it has been removed in one-third to one-fourth of the acreage in most fields. Most areas have several gullies that can be crossed by farm equipment and a few that cannot be crossed. The deeper gullies have eroded into the subsoil or into the substratum. Blowouts as much as 2 acres in size occur in some areas, and some of the larger blowouts are as deep as 6 feet. Around the sides of these blowouts are sand dunes 3 to 4 feet deep. Sand as much as 3 feet deep has accumulated along fence rows and in drainageways below the areas.

These soils are too sandy, sloping, and eroded for cultivation. Damage from past erosion makes them only fair for grass. Past erosion has also depleted the supply of plant nutrients. Nearly all of the acreage has been aban-

doned for crops and is no longer cultivated. The vegetation consists mostly of little bluestem, indiangrass, black grama, three-awn, silver bluestem, and forbs. Brushy plants in some areas are scattered yucca, shin oak, and sand sagebrush. The amounts and kinds of grass can be improved by reseeding native or improved grasses and by using careful management. (Dryland capability unit VIe–6, not placed in an irrigated capability unit, Sandyland range site)

Mobeetie Series

In the Mobeetie series are deep, calcareous, moderately coarse textured soils on hillsides and alluvial fans in the uplands. These soils are in the rolling and hilly parts of the county, below the edge of the High Plains. They developed under short and mid grasses.

The surface layer is dark grayish-brown, grayish-brown, and brown fine sandy loam that is generally about 10 inches thick. It has granular structure, is hard when dry, and is very friable when moist. Grass roots are abundant in this layer. The surface layer puddles easily if these soils are pastured when they are wet. As the puddled areas dry, a hard crust forms that is difficult to break.

The subsoil is grayish-brown or brown to very pale brown fine sandy loam about 36 inches thick. It has weak to moderate, prismatic and subangular blocky structure and is hard when dry and very friable when moist. Permeability is moderately rapid, and roots penetrate this layer easily. The lower part of the layer contains an accumulation of calcium carbonate; about 3 percent of the lower part of the subsoil, by volume, is accumulated calcium carbonate.

The substratum is calcareous, loamy alluvium washed down from the slopes above. This layer contains fragments of caliche and rock.

The thickness of the surface layer ranges from 5 to 12 inches. In a few places the surface layer is noncalcareous to a depth of 6 inches. All the layers generally contain a few fragments of limestone and a few quartz pebbles, and they have a loam texture in a few places. The depth to the layer where calcium carbonate has accumulated ranges from 18 to 36 inches. The content of visible calcium carbonate ranges from 1 to 5 percent, by volume.

The Mobeetie soils are more sandy than the Berthoud soils. They have a thinner, lighter colored surface layer and a more sandy subsoil than the Bippus soils. The Mobeetie soils are more sandy and have a less prominent horizon of calcium carbonate accumulation than the Mansker soils, and they are more clayey than the Likes soils.

The Mobeetie soils have moderate to low natural fertility. They are well drained and take in water at a moderate rate. Much of the water runs off before it soaks into the soils, however, and the solum is rarely moist below a depth of 50 inches. These soils are used mostly for range.

Mobeetie fine sandy loam, 3 to 8 percent slopes (MoC).—This soil is on hillsides and alluvial fans near Alanreed and Lefors and east of Lefors to the county line. In the layer where calcium carbonate has accumulated, the content of calcium carbonate is generally less than 5 percent, by volume. The subsoil erodes easily, and gullies that have perpendicular sides have formed in many intermittent drainageways. Gullies have also formed along some trails, and advancing escarpments occur on the sides of some drainageways.

In some areas mapped as this soil, about 12 percent of the acreage consists of other soils. Among these included soils are Potter soils, Mansker clay loam on ridges, Miles fine sandy loam on narrow ridges and benches, and Bippus fine sandy loam on foot slopes. Also included are small areas of Likes loamy fine sand, Badland, and Spur and Guadalupe fine sandy loams in drainageways. Each of these included areas is less than 5 acres in size.

This Mobeetie soil is good for grass, and it is used almost entirely for range. Blue grama, sideoats grama, and little bluestem are the main grasses. Scattered sand sagebrush, yucca, and catclaw also grow in some areas. The hazard of wind erosion is moderate, but the hazard of water erosion is moderately severe. (Dryland capability unit VIe–3, not placed in an irrigated capability unit, Mixedland Slopes range site)

Mobeetie-Mansker-Potter complex, 3 to 12 percent slopes (MxD).—About 65 percent of this complex is Mobeetie fine sandy loam, 15 percent is Mansker fine sandy loam, 10 percent is Potter soils, and 10 percent is other soils. The amount of each soil varies considerably in different parts of the county. This complex is extensive in the area of moderately coarse textured soils along the dissected margin of the High Plains (fig. 11).

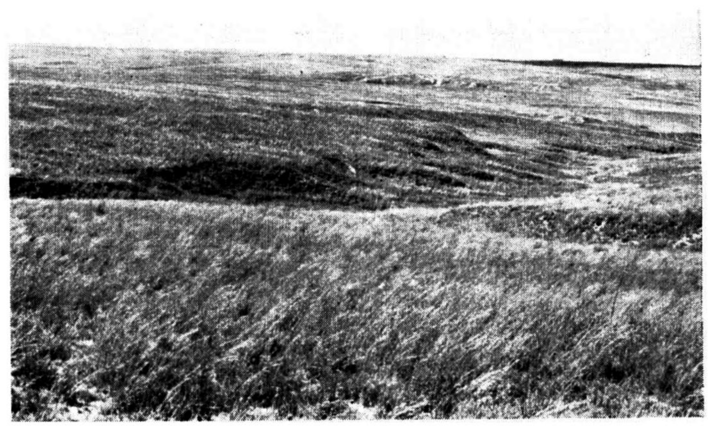

Figure 11.—**A typical area of the Mobeetie-Mansker-Potter complex.**

The Mobeetie soil is gently sloping to strongly sloping and is on hillsides; the Mansker soil is gently sloping to sloping and is on ridges; the Potter soils, mainly Potter fine sandy loams and Potter loams, are sloping to moderately steep and are on ridges and knobs. The Mobeetie soil has a profile like the one described for the Mobeetie series. A profile of the Mansker and Potter soils is described under the Mansker and Potter series.

Other soils and land types make up from 5 to 30 percent, or generally about 10 percent, of the areas mapped as this complex. Among these are small areas of Badland; ledges of hard caliche caprock, and areas of Rough broken land on escarpments and in subdued escarpment areas; Berthoud loam on hillsides; Mansker clay loam on ridges; Likes loamy fine sand on foot slopes; Bippus,

Spur, and Guadalupe fine sandy loams in drainageways; Hilly gravelly land on knobs and ridges; and Miles fine sandy loam in moderately sloping areas. Gullies have formed in some drainageways, and advancing escarpments occur on the sides of some drainageways.

The steep slopes make the soils of this complex unsuitable for cultivation, and most of the areas are used for range. The different soils of this complex support different kinds of vegetation. The main grasses on the Mobeetie and Mansker soils are blue grama, little bluestem, and sideoats grama. The main grasses on the Potter soils are little bluestem, sand bluestem, sideoats grama, three-awn, and hairy grama. Scattered yucca and catclaw also grow in some areas.

Because several different soils make up this complex, the soils are difficult to manage and it is difficult to use the areas for the maximum production of grass. More information on the use of these soils for range is given in the section "Use of the Soils for Range." (The Mobeetie and Mansker soils are in dryland capability unit VIe-3 and Mixedland Slopes range site, and the Potter soils are in dryland capability unit VIIs-1 and Very Shallow range site; these soils have not been placed in an irrigated capability unit)

Olton Series

The Olton series is made up of deep, dark-colored, fine-textured soils that are nearly level to moderately sloping. These soils are on uplands at the edge of and just below the edge of the High Plains. They developed under short native grasses.

The surface layer is brown to dark grayish-brown loam to clay loam, generally about 6 inches thick. It has granular structure and is very hard when dry and friable when moist. The surface layer sometimes seals over, and a crust forms after heavy rains. A compaction pan is likely to form if these soils are plowed at the same depth year after year.

The subsoil is generally dark grayish-brown to reddish-brown clay loam about 36 inches thick. It has moderate, medium, blocky structure and is extremely hard when dry and firm when moist. Permeability is moderately slow. The upper part of the subsoil is less dense in some places than in others, and the lower part is generally calcareous.

The underlying material is loamy and contains an accumulation of calcium carbonate. The underlying material appears to be loess in some places and outwash in others. In some areas this material appears to be related to the buried reddish clay loam that underlies the Pullman soils.

The thickness of the surface layer ranges from 4 to 12 inches. In a few places the subsoil is light clay or heavy sandy clay loam. The depth to the layer of calcium carbonate accumulation ranges from 24 to 60 inches. In areas that have a loam surface layer, the layer of the accumulation of calcium carbonate is absent in a few places.

The Olton soils are generally more reddish and have a less compact and less clayey subsoil than the Pullman soils. They are more clayey throughout than the Miles soils, and they have blocky structure in the subsoil.

The Olton soils are well suited to small grains, sorghum, and grass, and about one-third of their acreage is cultivated. Winter wheat is the principal crop, and blue grama and buffalograss are the main native grasses. The capacity of these soils to hold water and plant nutrients is high.

Olton clay loam, 1 to 3 percent slopes (OcB).—This soil is on ridges, mainly at the edge of the High Plains or nearby on remnants of the High Plains. The surface layer is generally brown or dark brown and ranges from 4 to 8 inches in thickness. The subsoil is generally about 36 inches thick. Erosion by wind and water has removed a few inches of the surface layer in most cultivated fields. A few shallow rills form after heavy rains in fields that have slopes of 2 to 3 percent.

As much as 5 percent of the acreage mapped as this soil is Zita silty clay loam; Mansker clay loam near the edges of areas mapped as this soil or on ridges within the areas; Bippus clay loam in drainageways; Olton clay loam in moderately sloping areas; and Olton loam.

About one-third of the acreage of this Olton soil is cultivated, and winter wheat and forage sorghum are the chief crops. This is a good soil for farming, but it is limited by moderately slow permeability. The surface layer crusts easily. The hazard of water erosion is moderate, and the hazard of wind erosion is slight. Runoff is moderate. (Dryland capability unit IIIe-2, irrigated capability unit IIe-1, Deep Hardland range site)

Olton clay loam, 3 to 5 percent slopes (OcC).—This soil is on ridges and hillsides below the edge of the High Plains. The areas are generally about 30 acres in size and are scattered, mostly south and east of Laketon. This soil has a thinner solum than the one for which a profile was described for the series. The surface layer is 4 to 6 inches thick, and the subsoil is generally about 30 inches thick. Most areas that have been cultivated are slightly eroded, and sheet erosion has removed a few inches of the surface layer. Rills and a few gullies that can be crossed by farm machinery occur in and near the natural drainageways.

Included in the areas mapped as this soil are a few eroded areas in old cultivated fields. Also included are areas of Olton loam and of Mansker clay loam on knobs.

This Olton soil is good for range, but it is marginal for crops. Most of the acreage is in range, but small grains, grain sorghum, and forage sorghum are grown in some areas. The yields of crops are limited because much of the water is lost through runoff. None of the acreage is irrigated. The hazard of water erosion is moderately severe, but the hazard of wind erosion is slight. (Dryland capability unit IVe-1, not placed in an irrigated capability unit, Deep Hardland range site)

Olton loam, 0 to 1 percent slopes (OmA).—This soil occupies a few small tracts on nearly level ridges and in concave areas. It occurs with more sloping Olton loams. Within the areas are a few small depressions that hold water for several days after heavy rains. The areas are scattered throughout the central and northeastern parts of the county. The surface layer is dark-brown or dark grayish-brown loam, generally about 8 inches thick. The subsoil is brown or dark-brown clay loam about 32 inches thick. In some cultivated fields, this soil has been slightly eroded by wind.

Included with this soil in mapping are areas of Mansker clay loam on ridges. Also included are areas of Olton clay loam and Miles fine sandy loam on low mounds.

About half of the acreage of this Olton soil is cultivated, and the rest is in range. Winter wheat, forage sorghum, and cotton are the chief crops. This is a good soil for crops. It is fertile and easily worked, and it takes water and holds it well. The hazard of wind erosion is slight. (Dryland capability unit IIce–5, irrigated capability unit I–2, Deep Hardland range site)

Olton loam, 1 to 3 percent slopes (OmB).—This soil is on ridges that are scattered throughout the southern, central, and northeastern parts of the county below the edge of the High Plains. The surface layer is about 7 inches thick and is mainly brown or dark-brown loam. The subsoil is generally about 45 inches thick. Erosion by wind and water has removed a few inches of the surface layer in most cultivated fields. A few shallow rills develop after a heavy rain in areas that have slopes of 2 to 3 percent.

Other soils make up as much as 10 percent of the acreage in the areas mapped as this soil. The included soils are Mansker clay loam on ridges, Olton clay loam, and Miles fine sandy loam.

This Olton soil is easily worked and is good for crops. It is limited, however, by the moderately slow rate at which it takes in water. Some water is lost through runoff. About half of the acreage is cultivated, and the rest is in range. Wheat, sorghum, and cotton are the chief crops. Only a few areas are irrigated. The hazard of wind erosion is slight, and the hazard of water erosion is moderate. (Dryland capability unit IIe–2, irrigated capability unit IIe–2, Deep Hardland range site)

Olton loam, 3 to 5 percent slopes (OmC).—This soil is on ridges and hillsides in areas that are scattered throughout the southern, central, and eastern parts of the county. The surface layer is generally brown. In most places the substratum is at a depth of less than 48 inches. The surface layer of this soil in most cultivated fields has been slightly eroded by wind and water. Rills and a few shallow washes have developed in most fields, and most of the surface layer has been removed in the shallow washes and along the edges of drainageways.

As much as 15 percent of some areas mapped as this soil is Bippus clay loam in drainageways, Mansker clay loam on knolls and ridges, Olton clay loam, Miles fine sandy loam, and small, gently sloping areas of Olton loam, mainly on narrow ridges. Also included is a small acreage of eroded soils in cultivated fields.

About one-fourth of the acreage of this Olton soil is cultivated, and the rest is in range. This soil is marginal for crops, but it is good for grass. Forage sorghum, grain sorghum, and winter wheat are the chief crops. Yields are limited by the loss of water on the moderate slopes. The hazard of wind erosion is slight, but the hazard of water erosion is moderately severe. (Dryland capability unit IVe–1, not placed in an irrigated capability unit, Deep Hardland range site)

Olton and Zita clay loams, 0 to 1 percent slopes (OzA).—This undifferentiated unit occurs in slightly concave or convex areas on the High Plains. It consists of about 80 percent Olton clay loam and 20 percent Zita clay loam. All of an area, however, may be Olton soil, Zita soil, or both. Generally, the Olton soil is on low ridges and the Zita soil is in shallow depressions. In some areas, however, the Olton soil is in small depressions, and the Zita soil is on low ridges. Some areas have gilgai relief. These soils occur with the Portales soils within large areas of Pullman soils.

In most cultivated fields, the surface layer of these Olton and Zita soils has been slightly eroded by wind. It has been only slightly eroded by water where the slopes are between one-half and 1 percent. The surface layer tends to be a few inches thicker in concave areas than in convex areas. The color of this layer ranges from dark gray to very dark grayish brown. The Olton soil has a profile similar to the one described for the Olton series. A profile of the Zita soil is described under the Zita series.

As much as 10 percent of a few areas mapped as this unit are Pullman and Portales clay loams. These included soils are on low ridges.

The soils of this unit are good for crops, and most of the areas are cultivated. Yields are higher in the concave than in the convex areas because runoff is received from the surrounding areas. Buffalograss and blue grama are the chief range grasses. Where irrigation is planned, further studies need to be made to determine the rate at which water is taken in and the water-holding capacity of the subsoil. The subsoil of the Olton soil has moderately slow permeability, and the subsoil of the Zita soil has moderate permeability. The hazard of wind erosion is slight in cultivated areas. (Dryland capability unit IIIce–2, irrigated capability unit I–2, Deep Hardland range site)

Olton and Zita clay loams, 1 to 3 percent slopes (OzB).—About 80 percent of this undifferentiated unit is Olton clay loam, and about 20 percent is Zita clay loam. All of any area, however, may consist of the Olton soil, of the Zita soil, or of both soils. These soils occur on low ridges and along drainageways on the High Plains or at the edge of the High Plains. The areas are scattered and are generally about 20 acres in size. The color of the surface layer and subsoil ranges from dark grayish brown to brown.

The surface layer in some cultivated fields of these soils is slightly eroded, and a few rills and shallow gullies form in cultivated fields after a heavy rain. The underlying material is several inches nearer the surface than that underlying the nearly level Olton and Zita clay loams. The profile of the Olton soil is like the one described for the Olton series. A profile of the Zita soil is described under the Zita series.

Other soils make up as much as 10 percent of some areas mapped as this unit. Among these included soils are Pullman clay loam, Mansker clay loam, and Portales clay loam along drainageways and around playa lakes.

The soils of this unit are fairly good for farming and are used mostly for crops. The hazard of wind erosion is slight, and the hazard of water erosion is moderate. Runoff is moderate. A crust forms easily on these soils. Where irrigation is planned, further studies need to be made to determine the permeability of the subsoil and the rate at which these soils take in water. (Dryland capability unit IIIe–2, irrigated capability unit IIe–1, Deep Hardland range site)

Portales Series

In the Portales series are moderately deep, dark-colored, calcareous, fine-textured soils that are nearly level or gently sloping. These soils are on uplands in the

High Plains part of the county. They developed under a cover of short native grasses.

The surface layer is brown to dark grayish-brown clay loam that is about 10 inches thick in most places. It has granular and subangular blocky structure and is hard when dry and friable when moist. The content of lime in this layer increases the hazard of blowing. A compaction pan is likely to form if this soil is tilled at the same depth year after year.

The subsoil is brown to light yellowish-brown clay loam that is generally about 14 inches thick. It has moderate, fine, subangular blocky structure and is very hard when dry and friable when moist. This porous layer is moderately permeable and is easily penetrated by roots. It contains an accumulation of calcium carbonate that is visible and makes up about 7 percent of the layer, by volume. This layer where calcium carbonate has accumulated is about 15 inches thick.

The underlying material is loamy and is probably loess. This layer has a high content of lime.

The surface layer ranges from 6 to 14 inches in thickness. In a few places this layer is noncalcareous to a depth of 6 inches. The thickness of the subsoil ranges from 10 to 20 inches. Depth to the layer where calcium carbonate has accumulated is generally about 22 inches, but it ranges from 18 to 30 inches. The thickness of that layer ranges from 8 to 30 inches, and the content of visible calcium carbonate ranges from 2 to 30 percent, by volume.

The Portales soils have a more deeply developed profile than the Mansker soils. They have a lighter colored surface layer than the Zita soils, and their surface layer is calcareous. The Portales soils are calcareous to the surface and have a less clayey and compact subsoil than the Pullman and Olton soils.

Most of the acreage of the Portales soils is cultivated. These soils are well suited to sorghum, small grains, and grass, and winter wheat and grain sorghum are the main crops. These soils are also well suited to irrigation, and they absorb water readily. The high content of lime causes chlorosis, or yellowing of the leaves, in some crops.

Portales clay loam, 0 to 1 percent slopes (PcA).—This soil is in small, slightly convex areas on the High Plains. The areas are scattered, and the largest number are near Grandview. The surface layer is 1 to 2 inches thicker than that of the gently sloping Portales soils. In most cultivated fields, wind erosion has removed a small amount of soil material from the surface layer.

Other soils make up as much as 10 percent of a few areas mapped as this soil. These included soils are Pullman and Zita clay loams in low places and Mansker and Portales clay loams on the tops and sides of low, gently sloping ridges.

This Portales soil is good for farming, but it is slightly limited by the calcareous surface layer. Most of the rainfall soaks in, and little runs off. The hazard of wind erosion is moderate. Most of the acreage is cultivated, and part of it is irrigated. The irrigated areas are generally included in large fields of other soils. (Dryland capability unit IIIce-3, irrigated capability unit IIe-3, Deep Hardland range site)

Portales clay loam, 1 to 3 percent slopes (PcB).—This soil is on low ridges, along drainageways, around playa lakes, and at the edge of the High Plains. The areas are scattered, and they are generally about 30 acres in size. The surface layer is generally 1 to 2 inches thinner than that of the more nearly level Portales soil. Also, wind erosion and water erosion have removed a few inches of the surface layer in most cultivated fields. A few rills and shallow gullies appear after a heavy rain in fields that have slopes of 2 to 3 percent.

Other soils make up as much as 10 percent of a few areas mapped as this Portales soil. These included soils are Portales clay loam in low places and on nearly level ridgetops; Mansker clay loam on ridges and knolls; and Zita, Olton, and Pullman clay loams in other areas. Also included are a few narrow, moderately sloping areas.

This Portales soil is good for farming, but it is limited by the calcareous surface layer and moderate slopes. The hazard of erosion by wind and water is moderate. This soil is used for dryland crops and for range. Winter wheat and grain sorghum are the main crops, and such short grasses as blue grama and buffalograss are the chief native grasses. (Dryland capability unit IIIe-3, irrigated capability unit IIIe-4, Deep Hardland range site)

Potter Series

The soils of the Potter series are loamy, very strongly calcareous, and shallow over caliche. These soils are on ridges in the rough, dissected areas, or breaks, that are below the edge of the nearly level High Plains. They have slopes of as much as 30 percent, but in most places the slopes are less than 12 percent.

The surface layer is dark grayish-brown to pale-brown gravelly loam to fine sandy loam that is generally about 8 inches thick. It has granular structure and is hard when dry and very friable when moist. This layer absorbs water readily, but the shallow depth limits the water-holding capacity. The soil material in the surface layer grades to that in the substratum.

The substratum, or underlying material, ranges from indurated caliche to a mixture of caliche and soil material high in content of calcium carbonate. It is pinkish in color and is generally associated with one of several caprocks that occur at the edge of the High Plains or the remnant of the High Plains. In most places the content of calcium carbonate is more than 30 percent, by volume.

The thickness of the surface layer ranges from 4 to 12 inches, which is the total depth to which the soil profile has developed. The boundary between the surface layer and the substratum ranges from abrupt to diffuse. The underlying material is several feet thick in most places.

The Potter soils are shallower than the Mansker soils. Unlike the Quinlan soils, they developed in material underlain by caliche.

These soils are used mostly for range. Sideoats grama, little bluestem, three-awn, and hairy grama are the main grasses, but the stand is moderate to thin. Scattered catclaw and yucca also grow in some areas, and some scrubby cedar trees grow on these soils in the southern part of the county. The caliche near the surface limits the capacity of these soils to hold water and plant nutrients. Also, runoff is excessive and the hazard of erosion is very severe. Some areas of these soils are mined for limestone caliche.

The Potter soils are mapped only in complexes with the Berthoud, Mansker, and Mobeetie soils.

Potter-Berthoud-Mansker complex, 5 to 20 percent slopes (PmE).—About 40 percent of this complex is Potter soils, 25 percent is Berthoud loam, 20 percent is Mansker clay loam, and 15 percent is other soils. The proportions of each soil vary widely in different parts of the county. These soils are moderately extensive along the caprock below the edge of the High Plains. The Potter soils are on knobs and ridges or in the sloping to steep areas. The Berthoud soil is sloping to moderately steep and lies below the Potter soils. The Mansker soil is on sloping ridges and knobs, generally above the Potter soils. The Potter soils have a profile similar to the one described for the Potter series. A profile of the Berthoud and Mansker soils is described under the Berthoud and Mansker series.

Although the proportion of other soils included in this complex is generally about 15 percent, it ranges from 5 to 35 percent. Among the inclusions are areas of Rough broken land on escarpments, areas of Badland, and areas of Mobeetie fine sandy loam and Bippus clay loam on the lower sides of hills. Also included are areas of Spur clay loam in drainageways, and gullies and advancing escarpments in drainageways.

The soils of this complex are fairly good for grass, and they are used mainly for range. The different soils, however, support different types of vegetation. Mainly little bluestem, sideoats grama, hairy grama, blue grama, three-awn, and catclaw grow on the Potter soils. The main grasses on the Berthoud and Mansker soils are blue grama, sideoats grama, and some scattered little bluestem.

Because several different soils make up this unit, the areas are difficult to manage for the maximum production of grass. The main limitations are shallowness, lack of moisture, and erosion on the steep slopes. Practices are needed that will increase the stand of native grasses. A good cover of native grasses will, in turn, reduce runoff and help to control erosion. More information on the use of these soils for range is given in the section "Use of the Soils for Range." (Potter soils are in dryland capability unit VIIs–1 and the Very Shallow range site, and Mansker and Berthoud soils are in dryland capability unit VIe–2 and the Hardland Slopes range site; the soils of this complex have not been placed in an irrigated capability unit)

Pullman Series

In the Pullman series are deep, dark-colored, fine-textured soils of the uplands. These soils are nearly level or gently sloping and are in the High Plains part of the county. They developed under a cover of short native grasses where the annual rainfall was about 21 inches.

In most places the surface layer is brown to dark grayish-brown clay loam about 6 inches thick. It has granular structure. The surface layer is hard when dry, friable when moist, and sticky when wet. The soil material in this layer is difficult to work. A heavy rain may cause sealing and crusting of the surface layer. A compaction pan is likely to form if this soil is tilled at the same depth year after year.

The subsoil is generally brown to dark grayish-brown clay about 40 inches thick. It has moderate, coarse and medium, blocky structure, is extremely hard when dry, and is very firm when moist. Permeability is slow, and roots have difficulty penetrating this layer. The upper part of the subsoil is noncalcareous, and the lower part is calcareous.

The substratum is calcareous loamy material, probably loess. In most places a buried layer of reddish clay loam, probably derived from loess similar to that in the substratum, underlies this material.

The thickness of the surface layer ranges from 4 to 10 inches, and the texture of the surface layer is silty clay loam in a few places. The depth to the horizon where calcium carbonate has accumulated ranges from 24 to 96 inches. In a few places near the edge of the High Plains, the subsoil is reddish brown. Also, the subsoil has a texture of heavy silty clay loam or heavy clay loam in a few places.

The Pullman soils have a more silty surface layer, are less grayish throughout, and have a stronger structure than the Roscoe soils. They have a more compact, clayey subsoil than the Olton soils. The Pullman soils are less limy, are more clayey, and have stronger blocky structure in the subsoil than the Zita and Portales soils.

The Pullman soils are well drained. They are well suited to small grains, sorghum, and native grasses, and most of the areas are cultivated. Winter wheat is the principal crop.

Pullman clay loam, 0 to 1 percent slopes (PuA).—This soil is in large, weakly convex areas on the High Plains. The clay loam surface layer and clay subsoil tend to be more reddish near the edge of the High Plains and where the slopes are between one-half and 1 percent than in other areas. Where this soil has been cultivated, it is slightly eroded by wind. In areas where the slopes are between one-half and 1 percent, this soil is slightly eroded by water.

As much as 3 percent of the acreage mapped as this soil consists of small areas of Randall clay and of areas of gently sloping Pullman, Zita, and Olton clay loams and of Roscoe clay. Each of these included areas is less than 5 acres in size. Also included are a few areas of Lofton silty clay loam on benches bordering playa lakes along the Carson County line. The Lofton soil is not mapped separately in this county.

This Pullman soil is well suited to both dryland and irrigated crops, but it is limited by the slowly permeable, dense clay in the subsoil. Surface runoff is slow, and the hazard of erosion is slight. The surface crusts easily if tillage is excessive. The main dryland crops grown on this soil are small grains and sorghum. The main irrigated crops are small grains, sorghum, and alfalfa. (Dryland capability unit IIIce–1, irrigated capability unit IIs–1, Deep Hardland range site)

Pullman clay loam, 1 to 2 percent slopes (PuB).—This soil is in weakly convex areas, mainly along drainageways or around playa lakes. The surface layer is generally about 4 inches thick, and the subsoil is generally about 36 inches thick. In some cultivated fields, erosion has removed about half of the surface layer. Also, part of the subsoil has been mixed with the surface layer by tillage.

As much as 8 percent of the acreage mapped as this soil consists of Mansker, Portales, Olton, and Zita clay loams. Each of these areas of included soils is less than 5 acres in size.

This Pullman soil is fairly good for crops, but it is limited by the gentle slopes and the slowly permeable, dense clay in the subsoil. This soil is well suited to small grains, sorghum, and native grasses, and winter wheat is the chief crop. The hazard of water erosion is moderate, and the hazard of wind erosion is slight. Surface runoff is moderate. Most of the water erosion has been caused by water that concentrates and flows down the nearly level slopes across this soil. The surface layer of this soil crusts easily. (Dryland capability unit IIIe-1, irrigated capability unit IIIe-1, Deep Hardland range site)

Quinlan Series

In the Quinlan series are reddish, medium-textured, calcareous soils that are shallow over red-bed material. These soils are on ridges in the uplands. They are in the hilly and rolling areas in the eastern part of the county. These soils developed under a cover of short and mid grasses.

The surface layer is reddish-brown to yellowish-red loam to very fine sandy loam that is generally about 8 inches thick. It has weak granular structure and is hard when dry and friable when moist. The surface layer absorbs water readily.

A transitional layer separates the surface layer and the substratum. The substratum is red or yellowish-red, calcareous, medium-textured, weakly cemented sandstone or packsand of the red beds.

The thickness of the surface layer ranges from 3 to 12 inches. The thickness of the transitional layer, between the surface layer and the substratum, ranges from 1 to 7 inches.

The Quinlan soils are shallower and have less well-defined horizons than the Woodward soils. They are more reddish than the Potter soils.

The Quinlan soils are used for range, but the yields of native grass are moderate to low. These soils are droughty because the steep slopes reduce the amount of water that soaks into the soils. The thin solum limits the water-holding capacity. The Quinlan soils are mapped only in a complex with the Woodward soils.

Randall Series

The Randall series consists of soils that are deep, grayish, fine textured, and poorly drained. These soils are on the bottoms of playa lakes on the High Plains. They have developed under alternate periods of flooding and drought. Western wheatgrass and buffalograss become temporarily established on these soils during dry periods. Sedges, rushes, and water-tolerant forbs are dominant in the vegetation when these soils are flooded.

The surface layer is gray to dark-gray clay that is generally about 12 inches thick. It has weak blocky structure. The surface layer is very hard when dry, very firm when moist, and sticky when wet.

Below the surface layer is dark-gray to grayish-brown soil material that is 2 to 3 feet thick. The soil material in this layer has weak blocky structure and is extremely hard when dry and very firm when moist. It is calcareous in some places and is mottled in places. Permeability is very slow.

The substratum consists of brownish strata of clayey material or of caliche.

Cracks form when these soils are dry, and some of the surface soil falls or washes into the cracks. When the soils again become wet, they swell and the cracks disappear. Thus, there is a slow circulation of soil material throughout the soil mass.

The surface layer ranges from 10 to 18 inches in thickness, and it is calcareous in a few places. The thickness of the soil material below the surface layer ranges from 2 to 3 feet.

Periodic flooding makes these soils unsuitable for cultivation, and the chief use is for grazing. The soils blow when the surface is bare and dry. Also, the surface layer seals over when these soils are wet, and a crust forms when they are dry.

Randall clay (Ra).—This is the only Randall soil mapped in the county. It is on the High Plains on the nearly level bottoms of intermittent lakes in areas as much as 300 acres in size. Runoff is received from the higher surrounding areas, and this soil is covered periodically by a few inches to several feet of water. The water remains for a long period, or until it evaporates. The surface layer has small depressions, or gilgai relief, caused by the cracking-sloughing-swelling characteristics of this soil under alternate cycles of drying and wetting.

This soil is mainly nearly level. Included in the areas mapped, however, are narrow sloping areas on the shore of the lake.

This is a poor soil for most uses because it is periodically flooded. It can be cultivated at times during dry years if the water from higher areas is diverted or if the lake is drained. This soil is difficult to till, however, and it is generally either too wet or too dry for cultivation. When the areas are flooded, they are frequented by migratory waterfowl. (Dryland capability unit VIw-1, not placed in an irrigated capability unit or range site but included in the surrounding range site)

Roscoe Series

In the Roscoe series are deep, dark-colored, fine-textured soils of the uplands. These soils are on nearly level benches above intermittent lakes on the High Plains. They developed under a cover of western wheatgrass, buffalograss, and blue grama.

The surface layer is gray to very dark grayish-brown clay, generally about 15 inches thick. It has subangular blocky structure and is very hard when dry and very firm when moist. The surface layer seals and crusts over after a heavy rain. A compaction pan is likely to form if tillage is at the same depth year after year.

Below the surface layer is dark-gray clay about 30 inches thick. The clay has blocky structure and is extremely hard when dry and extremely firm when moist. Permeability is slow, and roots have difficulty penetrating the clay. This layer is generally calcareous.

The underlying material is calcareous clayey alluvium and loess. In a few places, some lime has accumulated in the upper part. Drying causes the formation of cracks in this soil, and then, some of the surface soil sloughs or washes into the shrinkage cracks. Wetting causes the cracks to swell shut; thus, there is a slow circulation of the soil material throughout the soil mass.

The surface layer ranges from 10 to 20 inches in thickness, and it is calcareous in a few places. The depth to the underlying material ranges from 30 to 55 inches.

The structure is weak when these soils are moist, but it appears to be moderate to strong when they are dry.

These soils are more grayish and have a thicker, more clayey surface layer than the Pullman soils. Also, they have less well-defined horizons than the Pullman soils. They are better drained than the Randall soils.

The Roscoe soils are well suited to small grains, sorghum, and native grasses, and about half of the acreage is cultivated. Winter wheat is the principal crop. These soils are well drained, but they are difficult to work.

Roscoe clay (Rc).—This is the only Roscoe soil mapped in the county. It is on nearly level benches that are 3 to 10 feet above the level of some of the larger intermittent lakes on the High Plains. The areas are small and scattered and are generally about 80 acres in size. This soil is subject to some scouring where runoff from the higher slopes flows across it on the way to the playa lakes. The areas in range have small depressions, or gilgai relief, caused by the cracking, sloughing, and swelling of this soil under alternate cycles of drying and wetting. Included in the areas mapped as this soil are narrow areas of sloping soils along the lake shore.

This Roscoe soil is well suited both to dryland and irrigated crops. It is somewhat limited, however, by the clayey surface layer and the subsoil of dense, slowly permeable clay. Surface runoff is slow, and the hazard of wind erosion is slight. When this soil is dry, a crust forms on the surface. The surface seals over when the soil is wet. (Dryland capability unit IIIe-1, irrigated capability unit IIs-1, Deep Hardland range site)

Rough Broken Land

Rough broken land (Ro) consists of steep bluffs that are cut by canyons and drainage channels (fig. 12). These steep areas are extensive along and below the edge of the nearly level High Plains and along and below remnants of the High Plains that finger into the Rolling Plains. They occur in areas where the caprock has checked erosion of the Ogallala formation, the mantle of the High Plains.

On the sides of the bluffs and canyons in these areas, the slopes are generally about 25 percent, but they range from 12 to 50 percent. Local relief ranges from 30 to 200 feet, and sheer drops of 20 to 50 feet occur in places. The areas are generally about 50 acres in size, but a few areas are several hundred acres in size. In most places little or no soil development has taken place because of the rugged relief and the exposure to wind. There is a large amount of runoff in these areas, and erosion is active. This land type supports only a thin to moderately thick cover of vegetation.

Figure 12.—A typical area of Rough broken land.

About 20 percent of the acreage mapped as this land type is Mansker clay loam, 8 percent is Mobeetie fine sandy loam, 10 percent is Potter soils, another 10 percent is Berthoud loam, and 7 percent is other soils. The amount of each included soil varies in different parts of the county. The Mansker and Potter soils are on the tops and upper sides of the ridges and knobs. The Mobeetie and Berthoud soils occur above the stream channels and on narrow benches or foot slopes below the steeper soils and the caprock. Other soils are Spur clay loam in drainageways; very steep areas of bare, actively eroding Badland; areas of exposed red beds just east of Lake McClellan; Hilly gravelly land on gravelly knobs and ridges; and moderately sloping areas of Mansker fine sandy loam.

Although this land type is poorly suited to grass, a small amount of forage is produced and grazing is the main use. The chief grasses are sideoats grama, black grama, blue grama, little bluestem, and three-awn. Scattered yucca and catclaw and scattered redberry junipers grow in some areas. A moderate amount of forage is produced on the shallow and deep included soils. Between 5 and 10 percent of some areas, however, is inaccessible to livestock. Because the areas are made up of many soils and land types, they are difficult to manage and use efficiently. More information on the use of this land type for range is given in the section "Use of the Soils for Range."

This land type is also used as a refuge for antelopes, bobcats, eagles, coyotes, snakes, rabbits, and other kinds of wildlife. A few areas are mined for limestone gravel and caliche. (Dryland capability unit VIIs-2, not placed in an irrigated capability unit, Rough Broken range site)

Springer Series

The Springer series is made up of deep, brownish, coarse-textured soils of the uplands. These soils are in undulating and hummocky areas in the sandy parts of the county below the High Plains. They developed under a cover of tall and mid grasses and some brush.

The surface layer is brown loamy fine sand that is generally about 16 inches thick. It has granular and subangular blocky structure and is slightly hard when dry and very friable when moist.

The subsoil is reddish-yellow to brown fine sandy loam to heavy loamy fine sand that is generally about 30 inches thick. It has weak prismatic and subangular blocky structure. This layer is hard when dry and friable when moist. It has moderately rapid permeability and is readily penetrated by roots.

In most places the substratum is reddish-yellow, weakly calcareous sandy outwash and windblown material. In some places caliche of the Ogallala formation is at a depth of only 30 inches.

The surface layer is thickest in the less sloping areas, but the thickness ranges from 5 to 20 inches. The thickness of the subsoil ranges from 12 to 48 inches, and it is neutral in most places. In a few places there is a faint layer of calcium carbonate accumulation.

The Springer soils have a more sandy subsoil than the Brownfield and Miles soils. They are more reddish and have a more clayey subsoil than the Likes soils. Also, they are noncalcareous rather than calcareous like the Likes soils. The Springer soils are noncalcareous and have a thicker, more sandy, and more reddish surface layer than the Mobeetie soils.

Most of the acreage of Springer soils is in range, and yields of native grasses are good. The capacity of the subsoil to hold water and plant nutrients is moderate to low.

Springer loamy fine sand, undulating (Sa).—This soil is in nearly level or gently sloping areas where the slopes are complex. The areas are small. They are scattered throughout the sandy parts of the county, east and southeast of Lefors to the Wheeler County line. The surface layer and the subsoil are generally a few inches thicker than those of Springer loamy fine sand, hummocky. In cultivated fields the plow layer of this soil has been winnowed by wind, and most of the finer particles have been removed. In some places the texture of the present surface layer is fine sand.

It is difficult to measure the amount of soil material lost from this soil through erosion, but mounds of sand, 1 to 2 feet high, have accumulated in some fields and along fence rows. In a few blowout areas in some fields, erosion has cut into the subsoil or substratum. These blowout areas are as large as 1 acre in size, but their size is generally about one-fourth acre. The drainage pattern is poorly defined in the larger areas of this soil.

Other soils make up about 8 percent of most areas mapped as this soil. Among the included soils are Miles loamy fine sand, Miles fine sandy loam in depressions or on knolls, Springer loamy fine sand, hummocky, near the edges of these areas or on narrow ridges within these areas, and a few severely eroded areas as large as 7 acres in size.

Most of the rainfall soaks in, but this Springer soil is marginal for crops. The water-holding capacity of the subsoil is low. This soil is good for grass, and most of the acreage is used for pastures consisting of native grasses or grasses that have been introduced. A few fields are planted to dryland cotton and sorghum, and a few fields of alfalfa and grasses are irrigated by sprinklers. The chief native grasses that grow on this soil are indiangrass, switchgrass, sand bluestem, little bluestem, and sideoats grama. Sand sagebrush grows on most areas of range, and a moderate to thin stand of shin oak grows in some areas. (Dryland capability unit IVe–11, irrigated capability unit IVe–3, Sandyland range site)

Springer loamy fine sand, hummocky (Sb).—This soil is on irregular, choppy ridges and on hillsides in the sandy, rolling areas in the central and eastern parts of the county. The slopes are generally about 5 percent. The surface layer is about 12 inches thick in most places, but the subsoil is only 8 inches thick in a few places. The subsoil has a texture of fine sandy loam to loamy fine sand. Where this soil is adjacent to the Likes soils, the lower part of its subsoil is generally calcareous.

In most places where this soil is in cultivated fields, it has lost about half of the original surface layer through erosion. The rest of the soil material in the surface layer has been winnowed by wind, and its texture is now fine sand. All of the surface layer has been removed and the subsoil is exposed in about one-sixth of the acreage. A few shallow gullies have eroded into the subsoil, and there are a few blowout areas, less than 1 acre in size, in most fields. Accumulations of sand, as much as 3 feet high, have collected in fence rows around old fields. The only evidence of erosion in the areas in range are the few advancing scarps in narrow drainageways.

Included with this soil in mapping are small areas of Tivoli fine sand on dunes; Miles loamy fine sand, Likes loamy fine sand, and gravelly soil material on knobs; Mansker fine sandy loam; and areas of red beds or of loamy calcareous material that crop out on the hillsides. Each of these included areas is less than 5 acres in size.

This Springer soil is good for grass, and most of the acreage is used for grazing. Some old fields that were formerly cultivated have been abandoned. The vegetation is the same as that on Springer loamy fine sand, undulating. Runoff on this soil is slow, and most of the rainfall soaks in. Practices such as use of diversion terraces, however, help to protect this soil from erosion. Also, overseeding of native grasses improves the quality of the forage and provides additional protection for this soil. (Dryland capability unit VIe–6, irrigated capability unit IVe–3, Sandyland range site)

Spur Series

In the Spur series are dark-colored, moderately deep, loamy, calcareous soils of the bottom lands. These soils are on the flood plains of most of the streams that drain the rolling and hilly areas below the High Plains. The kinds of native plants that grow on them vary, mainly as a result of differences in the texture of the surface layer.

The surface layer is dark grayish-brown to grayish-brown clay loam to fine sandy loam that is generally about 15 inches thick. It has subangular blocky and prismatic structure and is very hard when dry and friable when moist. The soil material in this layer is easy to work, but excessive tillage destroys the good structure. A compaction pan is likely to form if this soil is plowed at the same depth year after year. Also, a surface crust forms after a heavy rain.

Just below the surface layer is dark grayish-brown to light yellowish-brown clay loam about 30 inches thick. It has subangular blocky and prismatic structure and is very hard when dry and friable when moist. This layer is calcareous. It is moderately permeable and is easily penetrated by roots.

The substratum is stratified, brownish, calcareous, loamy and sandy alluvium washed from soils in watersheds in the uplands. Some areas are flooded occasionally, and the floodwaters deposit a small amount of fresh alluvium.

The surface layer ranges from 6 to 18 inches in thickness, and it is noncalcareous in a few places. The texture of the layer just below the surface layer is sandy clay loam or loam in some places. Depth to the substratum ranges from 24 to 60 inches. In a few places the water

table is at a depth of 4 to 6 feet. One or more horizons of a buried soil are exposed in some vertical cuts in the streambanks.

The Spur soils are darker colored and more clayey than the Lincoln soils. The layer just below their surface layer contains more clay than the comparable layer in the Guadalupe soils. The Spur soils have a more calcareous surface layer and they have more stratified soil material just below the surface layer and in the substratum than the Bippus soils. Also, they are on flood plains, rather than on gently sloping uplands. The Spur soils are better drained and have more clayey soil material just below the surface layer than the Sweetwater soils.

The Spur soils are fertile. They are used mostly for range, however, because the areas near the headwaters of streams are so narrow and scattered that it is impractical to cultivate them. Some of the larger areas are cultivated, and a few areas are irrigated. Alfalfa, cotton, sorghum, and small grains are the main crops, and yields are moderate to high.

Spur clay loam (Sc).—This soil is on nearly level benches on flood plains above the channels of streams. It is below the areas where the headwaters of streams occur that drain the dissected margin of the High Plains. The surface layer is generally slightly darker than that of the Spur fine sandy loam mapped with the Guadalupe soil. The layer just below the surface layer is sandy clay loam in a few places. Some areas are flooded occasionally, but the floodwaters recede in a few hours, and damage is generally only slight. Water from drainageways in the uplands has cut gullies in some places, and meandering stream channels are cutting into the edges of some areas. In some places the streams have cut to so great a depth that the areas are no longer flooded.

Included with this soil in mapping are small areas of Bippus clay loam at the base of slopes in the uplands; narrow areas of soil material along the present stream channels and in old stream channels; and soil material on short slopes between benches and in gently sloping areas. Also included are narrow areas of Spur and Guadalupe fine sandy loams and of Lincoln soils, generally on benches that are lower than those on which this soil occurs. Each of the included areas is less than 5 acres in size.

Runoff is slow on this Spur soil. The hazard of wind erosion is slight. This soil is one of the best in the county for farming, and the larger areas are well suited to dry-farmed and irrigated crops. The main crops are alfalfa. cotton, forage sorghum, grain sorghum, and winter wheat. Blue grama and buffalograss are the main grasses in areas in range. (Dryland capability unit IIce–1, irrigated capability unit I–2, Loamy Bottomland range site)

Spur and Guadalupe soils (Sg).—This undifferentiated mapping unit is made up of about 60 percent Spur fine sandy loam and about 40 percent Guadalupe fine sandy loam. All of an individual area, however, may be Spur fine sandy loam, Guadalupe fine sandy loam, or both. These soils are on nearly level or gently undulating benches on flood plains above the channel of the stream. They occur along the upstream reaches of streams that drain the moderately coarse textured soils along the dissected margin of the High Plains. A profile of each of these soils is described under the Spur and the Guadalupe series.

In most cultivated areas of these soils, the surface layer has been thinned a few inches by wind erosion. Meandering stream channels are cutting away the edges of some areas, and water from drainageways in the uplands is cutting gullies in some areas. A few areas are flooded frequently, and most areas are flooded occasionally. A few areas are now so high above the entrenched channel that they are no longer flooded.

Included with these soils in mapping are small areas where the texture of the surface layer is loamy fine sand, very fine sandy loam, or loam. Also included is soil material in narrow stream channels; soil material on short, sloping benches between the flood plains; areas of Bippus fine sandy loam on the upland side of some areas; and Spur clay loam, Lincoln soils, and Tivoli fine sand on low dunes on the stream side of some of these areas. Each of the included areas is less than 5 acres in size.

Most of the rainfall soaks into the soils of this unit. Only a small amount runs off. The soils are good for grass and field crops, but the cultivated areas are moderately susceptible to wind erosion. The larger areas can be cultivated and irrigated more practically than the smaller ones. Alfalfa, winter wheat, and forage sorghum are the main crops. Short, mid, and tall grasses grow on these soils, and a thin stand of sand sagebrush and scattered cottonwood trees also grows in some places. (Dryland capability unit IIIe–4, irrigated capability unit I–4, Loamy Bottomland range site)

Sweetwater Series

In the Sweetwater series are dark-colored, loamy soils that are poorly drained. These soils are on bottom lands along the North Fork Red River, McClellan Creek, and Skillet Creek and along tributaries of those streams. They developed in wet areas where the water table is generally within 2 feet of the surface. The native vegetation was water-tolerant grasses, sedges, rushes, and trees.

The surface layer is very dark gray, calcareous silty clay loam that is generally about 10 inches thick. It has subangular blocky structure and is very hard when dry and friable when moist. The surface layer has a high content of organic matter and is gleyed and mottled.

Just below the surface layer is gray to very pale brown sandy clay loam that is usually wet. This material is structureless and is very hard when dry and very friable when moist. It is calcareous and is mottled with a brownish color. The upper part of this layer tends to be more clayey than the lower part.

The substratum consists of calcareous sandy alluvium. In it thin layers of loam or clay as much as 6 inches thick are common.

The thickness of the surface layer ranges from 10 to 15 inches, and the texture of that layer ranges from silty clay loam to fine sandy loam. The texture of the soil material just below the surface layer ranges from sandy clay loam to fine sand. The mottles are faint in some places and prominent in others.

The Sweetwater soils have a darker, more clayey surface layer than the Lincoln soils, and they have a high water table. The layer just below the surface layer is more sandy than that in the Spur and Guadalupe soils.

The Sweetwater soils are poorly drained. They are better suited to the production of native grasses than to other uses because it is not practical to drain them.

Sweetwater soils (Sw).—These are the only Sweetwater soils mapped in this county. They are on low, weakly undulating bottom lands only a few feet above the level of the adjacent streams. Surface drainage is very slow, and water ponds in the low places for several months at a time (fig. 13). Most of the time, water flows in the streams adjacent to these soils. Occasional overflows deposit a small amount of additional material on these soils and causes some scouring.

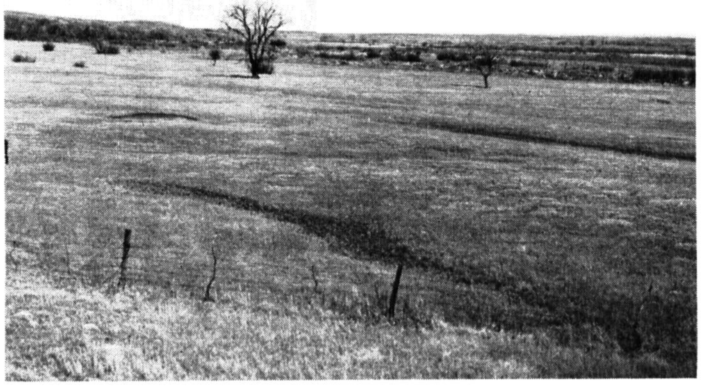

***Figure 13.*—Water standing in low areas of the bottom lands where the Sweetwater soils occur.**

As much as 10 percent of the acreage mapped as these soils is Tivoli fine sand, Lincoln soils, areas of soil material in narrow sloughs, and Sweetwater soils that have slopes of 1 to 4 percent. The sloping areas are at the base of the uplands, and water seeps from them most of the time. Each of the included areas is less than 5 acres in size. In as much as 50 percent of the acreage, the darkened surface layer is less than 10 inches thick or has been less darkened by organic matter than is normal for these soils. The yields of native grasses grown for hay and grazing are moderate to high. The chief vegetation is sedges, rushes, eastern gamagrass, switchgrass, and indiangrass, but willow, cottonwood, and saltcedar also grow on these soils. Some areas are slightly saline and support alkali sacaton. (Dryland capability unit Vw–3, not placed in an irrigated capability unit, Loamy Bottomland range site)

Tivoli Series

The soils of the Tivoli series are deep, light colored, and coarse textured. These soils are on dunes and ridges along the larger streams in the uplands of the eastern part of the county. They developed in sand under tall and mid grasses.

The surface layer is brown fine sand or loamy fine sand that is generally about 7 inches thick. It has weak granular structure and is loose when dry or moist.

The underlying material is light-brown fine sand that is several feet thick. It is loose both when dry and moist. Permeability is rapid, and this layer is easily penetrated by roots.

The surface layer ranges from 5 to 9 inches in thickness. The texture of the underlying material is light loamy fine sand in a few places. In some places this soil is calcareous. Fragments or layers of weakly cemented sandstone occur below the surface layer in some places.

The Tivoli soils are more sandy than the Miles, Likes, and Springer soils.

The Tivoli soils are too sandy for cultivation, and they have low natural fertility. Bare areas blow easily. Therefore, care is needed to prevent overgrazing of the native grasses that stabilize these sands. Big sandreed, sand bluestem, little bluestem, and sideoats grama are the main grasses. Shin oak, sand sagebrush, skunkbush, yucca, and wild plum also grow on these soils.

Tivoli fine sand (Tf).—This soil occupies dunes that are 10 to 40 feet high. Small areas occur along the larger creeks in the central and eastern parts of the county, but the largest areas, some over a thousand acres in size, are along the North Fork Red River east of Lefors. A few areas, generally less than an acre in size, are actively eroding. This soil is generally noncalcareous.

Included with this soil in mapping are areas of Likes loamy fine sand, Mansker clay loam, Miles loamy fine sand, and Springer loamy fine sand. The included soils are generally in concave areas between the dunes. Each of the included areas is less than 5 acres in size. The acreage of included soils makes up as much as 5 percent of the total acreage in areas mapped as this soil.

This Tivoli soil is used chiefly for grazing, although it is poorly suited to grass because it is so sandy. It is highly susceptible to wind erosion. (Dryland capability unit VIIe–1, not placed in an irrigated capability unit, Deep Sand range site)

Tivoli complex (Tm).—About 75 percent of this complex is calcareous Tivoli loamy fine sand. About 10 percent is Likes loamy fine sand, another 10 percent consists of outcrops of weakly cemented sandstone, and about 5 percent consists of other soils or land types. A profile of the Likes soil is described under the Likes series. The areas of this complex are moderately extensive and occur with outcrops of the lower and sandy part of the Ogallala formation. The slopes range from 3 to 15 percent, but they are generally about 7 percent. The bare areas and the steeper areas are eroded easily. They are cut by gullies, which show the progress of gradual erosion of the Ogallala formation.

The Tivoli soil is on dunes and ridges, and the Likes soil is in small depressions on the lower slopes. The almost bare outcrops of weakly cemented sandstone and of sandy calcareous material are on ridges and knolls and in areas where the slopes are between 8 and 15 percent.

Among the soils included in this complex are areas of Potter soils on ridges and a few areas of Hilly gravelly land and Badland. Also included are small areas of Springer loamy fine sand.

The soils of this complex are used for range. They support a moderate stand of tall and mid grasses and scattered patches of sand sagebrush, wild plum, skunkbush, and shin oak. Fertility is low, and these soils are highly susceptible to wind erosion. They need good management that will improve the stand of grass and reduce erosion by wind and water. The areas are frequently used as a refuge by many kinds of wildlife. (Dryland capability unit VIe–6, not placed in an irrigated capability unit, Sandyland range site)

Woodward Series

In the Woodward series are moderately deep, medium-textured soils that are calcareous. These soils occupy hilly and rolling areas of the uplands in the eastern part of the county. They developed under short and mid grasses.

The surface layer is reddish-brown loam to very fine sandy loam, generally about 9 inches thick. It has granular structure and is hard when dry and friable when moist. In this layer grass roots are abundant.

Just below the surface layer is reddish-brown to light-red very fine sandy loam to light clay loam that is generally about 16 inches thick. This material has moderate subangular blocky and prismatic structure and is hard when dry and friable when moist. It has moderately rapid permeability and can be readily penetrated by roots. In a few places the lower part of this material contains a weakly defined layer where calcium carbonate has accumulated.

The substratum is made up of medium-textured sediments of the Permian red beds. It is calcareous.

The surface layer ranges from 6 to 15 inches in thickness. In a few places it is noncalcareous to a depth of 6 inches. The layer just below the surface layer ranges from 12 to 30 inches in thickness. Concretions occur throughout the solum in some areas. The depth to the substratum ranges from 18 to 40 inches, but it is generally about 25 inches.

The Woodward soils are more reddish and contain more silt than the Mobeetie and Berthoud soils. They developed in material from the red beds, rather than in alluvium like that in which the Berthoud soils developed. The Woodward soils are deeper than the Quinlan soils and are dark colored to a greater depth.

The Woodward soils are used for range, and blue grama, sideoats grama, and little bluestem are the main grasses. Moderate yields are obtained. Although these soils absorb water readily, the steep slopes reduce the amount of water that soaks in. As a result, these soils are seldom moist below a depth of 48 inches. Also, because of the steep slopes, water erosion is a serious hazard.

Woodward-Quinlan complex, 5 to 50 percent slopes (WcF).—About 70 percent of this complex is Woodward loam, 20 percent is Quinlan loam, and 10 percent is other soils and land types. This complex includes all areas of soils developed in material from the red beds and all exposed areas of the red-bed formation in the county that it is practical to show on a map. These areas are generally about 60 acres in size and are scattered along McClellan Creek and along the North Fork Red River in the eastern part of the county.

The Woodward soil is generally on hillsides; some areas of it are moderately sloping and others are strongly sloping. The Quinlan soil is on or adjacent to small knobs and narrow ridges of almost bare red-bed material. The profile of the Woodward soil is like the one described for the Woodward series. A profile of the Quinlan soil is described under the Quinlan series. Erosion is active in the strongly sloping areas and in the exposed areas of the red-bed material in this complex. Advancing scarps, 1 to 2 feet deep, occur in and on the sides of some drainageways. The hazard of further water erosion is serious, but the hazard of wind erosion is slight.

Among the other soils included in this complex are Hilly gravelly land on knobs and ridges, Likes and Springer loamy fine sands, and Tivoli fine sand on low dunes. Also included are Mobeetie fine sandy loam on hillsides and Spur clay loam in drainageways.

The steep slopes and the susceptibility to water erosion make the soils of this complex suitable only for range. The soils are fairly good for grass, but they are not suitable for field crops. A few areas are used as a source of material for repairing and building roads. (Dryland capability unit VIe–2, not placed in an irrigated capability unit, Mixedland range site)

Zita Series

In the Zita series are deep, dark-colored, fine-textured soils that are well drained. These soils are nearly level or gently sloping and are on uplands of the High Plains.

The surface layer is brown to very dark grayish-brown clay loam that is generally about 12 inches thick. It has moderate granular and subangular blocky structure, except in the areas that have been plowed. In the plowed areas the structure is weak granular. This layer is very hard when dry and friable when moist. The soil material is easy to work, but a compaction pan is likely to form if tillage is at the same depth year after year. Also, the surface seals and a crust forms after heavy rains.

Just below the surface layer is brown, calcareous clay loam that has moderate subangular blocky and prismatic structure and is generally about 12 inches thick. This layer is moderately permeable and is easily penetrated by roots. The amount of calcium carbonate increases with increasing depth.

The substratum is calcareous loamy material that is probably loess. It has a high content of calcium carbonate.

The surface layer ranges from 8 to 15 inches in thickness, and the texture of that layer is silty clay loam in a few places. The layer just below the surface layer ranges from 5 to 24 inches in thickness, and it has a texture of silty clay loam in some places. Depth to the horizon where a large amount of calcium carbonate has accumulated ranges from 20 to 36 inches, but that horizon is generally at a depth of about 24 inches.

The Zita soils have a thicker surface layer than the Pullman and Olton soils. Also, they lack a compact blocky subsoil.

The profile of the Zita soils is similar to that of the Portales soils, but they have a darker, noncalcareous surface layer. They are deeper than the Mansker soils, and they have a noncalcareous surface layer.

The Zita soils are well suited to small grains, sorghum, and native grasses, and most of the areas are cultivated. Winter wheat is the principal crop. In Gray County the Zita soils are mapped only in undifferentiated units with the Olton soils.

Use and Management of Soils

The soils of Gray County are used mainly for dryland crops and for pasture or range. This section explains how the soils may be managed for these main purposes, and also for irrigated crops or pasture, planting trees, providing habitats for wildlife, and building highways,

farm ponds, and similar engineering structures. It also gives the predicted average yields of the principal dry-farmed and irrigated crops grown under two levels of management for the arable soils. In describing management, the method of presenting information is that of mentioning general practices suitable for all the soils, then grouping soils that require similar management, describing the group, and suggesting suitable management practices.

Use of Soils for Crops and Pasture

Since the county was settled, its agricultural economy has been based on cattle ranching and wheat farming. In recent years, however, a larger acreage has been planted to grain sorghum. Cotton, alfalfa, and other small grains are also grown.

Winter wheat is generally planted early in fall. Most fields are grazed by stocker calves or beef cattle late in fall and in winter (fig. 14). The cattle are removed early in spring to allow the wheat to mature.

Figure 14.**—Stocker cattle grazing winter wheat in a field of Pullman clay loam on the High Plains.**

Grain sorghum and forage sorghum are seeded late in spring. Forage sorghum is grazed or is harvested as silage, bundle feed, or cane hay.

Cotton is generally dryfarmed on the sandy soils in the southeastern part of the county. In this county most of the cotton grown on the soils of the High Plains is irrigated. Gray County appears to be near the northern limit of the region where cotton can be grown successfully. The late planting dates and the early dates when frost occurs reduce the quantity and the quality of yields in some years.

Alfalfa grows well on the soils of bottom lands or under irrigation. Most of the hay in this county is grown on the subirrigated soils. These are generally the Sweetwater, Lincoln, Guadalupe, and Spur soils that are adjacent to creeks or rivers. The hay in these areas generally consists of tall native grasses.

At present, irrigated grasses are allowing diversification of operations on some of the farms in the county. The grasses are grazed by stocker cattle, beef herds (fig. 15), or dairy cows, or are cut for hay.

Figure 15.**—Beef cattle grazing switchgrass in an irrigated pasture of Pullman clay loam.**

Barley and oats are grown on a moderate acreage each year. The size of the acreage depends on the market and on the amount of moisture in the soils at planting time. Favorable yields of other crops, such as corn, castor-beans, cowpeas, guar, millet, flax, potatoes and other vegetables, safflower, sesame, soybeans, sugarbeets, sweet-clover, vetch, and Austrian winter peas have been obtained on commercial or experimental plots. Peanuts, melons, fruits, and berries grow well on the sandy soils. Trials in local fields indicate that these crops do well under irrigation.

The rough and rolling areas of the county are used for range. Many sandy, eroded, or steep soils that were formerly cultivated have been seeded to native grasses in the last 10 years.

Management of soils for dryland farming

The main crops grown on dryland in this county are wheat, grain sorghum, and forage sorghum. Among the practices needed to grow these crops successfully under dryland farming are a cropping system that conserves soil and water, good management of crop residue, contour farming, stubble mulching, and emergency tillage. Field terraces, diversion terraces, and grassed waterways are also needed on some of the soils. Tillage should be kept to a minimum; the soils should be tilled only when necessary to prepare the seedbed and to control weeds. The application of these practices to specific soils or groups of soils is discussed under the capability units in the section "Capability Groups of Soils."

Capability groups of soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.

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Capability Classes, the broadest grouping, are designated by Roman numerals I through VIII. The numerals indicate progressively greater soil limitations and narrower choices for practical use. Soils in class I have the fewest limitations, the widest range of use, and are subject to the least risk of damage when they are used. Soils of class II have limitations that moderately reduce the choice of plants or that make some conservation practices necessary. Soils of class III have severe limitations that reduce the choice of plants, make special conservation practices necessary, or both. Soils in class IV have very severe limitations that restrict the choice of plants, make very careful management necessary, or both.

Soils in classes V, VI, VII, and VIII have limitations that are difficult to remove without major reclamation; their use is restricted largely to pasture, range, woodland, recreation, or wildlife food and cover. Soils in class V are not likely to erode, but they are wet or have other unfavorable features that prevent normal tillage for cultivated crops. Soils in class VI generally are not suited to cultivated crops, because they are steep, susceptible to severe erosion, droughty, or otherwise severely limited. Soils in class VII are more limited than those in class VI, but under careful management can safely be used for pasture or range, woodcrops, or wildlife food and cover. In class VIII are soils and landforms so rough, shallow, or otherwise severely limited that they produce very low yields of crops, forage, or wood products. Such areas may provide attractive scenery, have value as catchment basins for water, serve as sites for recreation, or furnish food and cover for wildlife.

Capability Subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses indicated by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

Capability Units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an arabic numeral to the subclass symbol, for example, IIe-2. Thus, in one symbol, the Roman numeral designates the degree of soil limitation; the small letter indicates the kind of limitation; and the arabic number distinguishes the capability unit from others in the same subclass. The capability units are not numbered consecutively in Gray County, because not all of the capability units used in Texas are in this county.

Following are descriptions of the dryland capability units in Gray County.

DRYLAND CAPABILITY UNIT IIce-1

Only Spur clay loam is in this capability unit. This is a deep, nearly level soil that has a moderately permeable subsoil of clay loam and is on bottom lands. This soil is high in natural fertility and takes in water readily. Some of the areas receive extra moisture, but low rainfall limits yields most of the time. Wind erosion is a slight hazard.

This is a good soil for farming, and it is well suited to field crops and grasses. Most of the areas, however, are in grass because they are small and in out-of-the-way places that are impractical to cultivate. Where this soil is cultivated, small grains, forage sorghum, and alfalfa are the principal crops. Cotton, grain sorghum, and nursery crops are also grown.

Management of this soil includes controlling erosion and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residues, and emergency tillage. Some areas need diversion terraces and grassed waterways to carry runoff from the adjacent slopes.

A cropping system that includes sorghum, alfalfa, or other crops that produce a large amount of residue is well suited. The residue of these crops lessens the crusting of the surface layer and protects this soil from blowing. The residue can be worked into the soil in spring after the critical period of wind erosion.

DRYLAND CAPABILITY UNIT IIce-5

Olton loam, 0 to 1 percent slopes, is the only soil in this capability unit. It is deep and has moderate permeability. The subsoil is clay loam and has moderately slow permeability. This soil is high in natural fertility, but low rainfall limits yields most of the time. Wind erosion is a slight hazard.

This is a good soil for farming, and most of the areas are cultivated. It is well suited to small grains, sorghum, cotton, and grass. Winter wheat and grain sorghum are the main crops, but forage sorghum and cotton are also grown on a small acreage. The main native grasses are blue grama and buffalograss.

Management of this soil includes controlling erosion, conserving moisture, and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, and emergency tillage. Field terraces, contour farming, diversion terraces, and grassed waterways are needed in some areas.

A cropping system that includes grain sorghum, wheat, or other crops that produce a large amount of residue is well suited. If the residue is kept on the surface during the critical blowing period in spring, it provides good control of erosion. Emergency tillage helps to control wind erosion in fields where the cover of plants or crop residue is inadequate.

DRYLAND CAPABILITY UNIT IIe-2

Only one soil, Olton loam, 1 to 3 percent slopes, is in this capability unit. It is deep and gently sloping and occurs below the edge of the High Plains. The subsoil is clay loam that has moderately slow permeability. This soil has high natural fertility. The hazard of wind erosion is slight, and the hazard of water erosion is moderate.

This is a good soil for farming, but it is slightly limited by its gentle slopes. It is well suited to grass and to small grains, grain sorghum, forage sorghum, and cotton, but only a few areas are cultivated. In the areas that are cultivated, winter wheat and grain sorghum are the principal crops, but forage sorghum, cotton, and barley are also grown on a small acreage. The native grasses are mainly blue grama and buffalograss.

Management of this soil includes control of erosion and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, emergency tillage, field terracing, and contour farming. Diversion terraces and grassed waterways may be required in some areas.

A cropping system that includes wheat, grain sorghum, or other crops that produce a large amount of residue is well suited. The residue, kept on the surface, provides good control of erosion. Emergency tillage helps to control wind erosion in fields that do not have an adequate cover of plants.

DRYLAND CAPABILITY UNIT IIIce-1

Only one soil, Pullman clay loam, 0 to 1 percent slopes, is in this capability unit. This is a deep soil of the High Plains. It has a subsoil of blocky clay that is slowly permeable and tends to impede the movement of water, air, and roots. This soil has high natural fertility, but low rainfall limits yields most of the time. The hazard of wind erosion is slight.

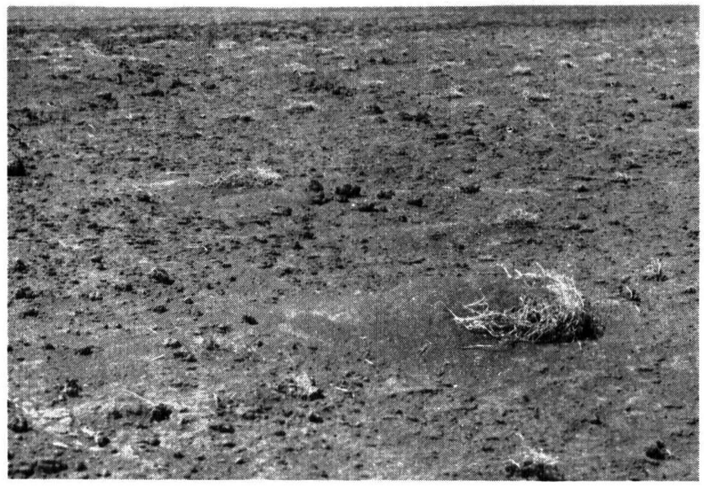
This is a fairly good soil for farming, but it is limited by the clayey subsoil that takes in water slowly and the surface crust that forms after rains. Most of the acreage is cultivated. This soil is well suited to small grains, sorghum, and grass, and the areas are suitable for large-scale farming. Winter wheat and grain sorghum are the principal crops, but forage sorghum, barley, oats, and cotton are also grown on a small acreage. The main native grasses are buffalograss and blue grama.

Management of this soil includes controlling erosion, conserving moisture, and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, and emergency tillage. Field terraces, diversion terraces, contour farming, and grassed waterways are also needed in some areas. Contour farming is used to slow runoff and to allow more water to soak into the soil.

A cropping system that includes wheat, grain sorghum, or other crops that produce a large amount of residue is well suited. Keeping the crop residue on the surface (fig. 16) lessens crusting, controls erosion, and holds water from rain or snow until it soaks into the soil. After the critical period of wind erosion, the residue can be worked into the soil to improve the structure and tilth.

DRYLAND CAPABILITY UNIT IIIce-2

Only one mapping unit, Olton and Zita clay loams, 0 to 1 percent slopes, is in this capability unit. These soils are on the High Plains and are deep and nearly level. They have a subsoil of clay loam that has moderate or moderately slow permeability. Air, moisture, and roots move readily through the profile. The hazard of wind erosion is slight, and natural fertility is high. Low rainfall, however, limits yields most of the time.



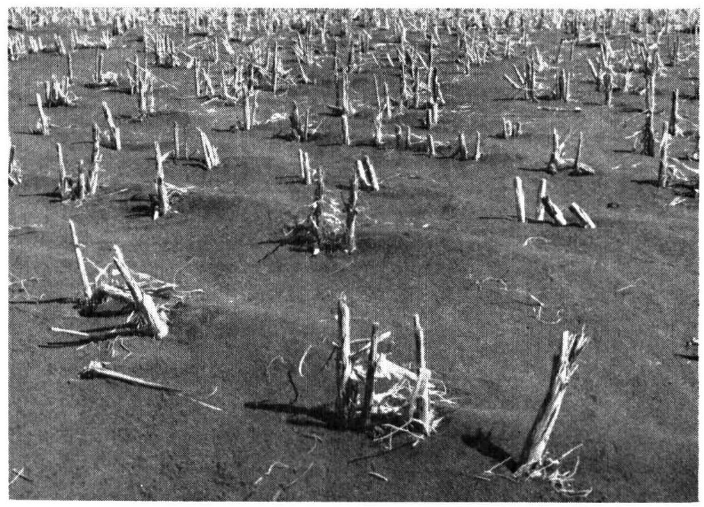


Figure 16.—**Two fields of Pullman clay loam, 0 to 1 percent slopes, where wind erosion has been active. In the upper picture, the field has been plowed recently and much of the material from the surface layer has blown onto the adjacent field shown in the lower picture. In the lower picture, the sorghum stubble catches the drifting soil material and prevents further soil blowing.**

These are good soils for farming, and most of the acreage is cultivated. The soils are well suited to sorghum, small grains, cotton, and grass. Grain sorghum and winter wheat are the principal crops, but forage sorghum, oats, barley, and cotton are also grown on a small acreage. The main native grasses are blue grama and buffalograss.

Management of these soils includes controlling erosion, conserving moisture, and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, and emergency tillage. Field terraces, diversion terraces, contour farming, and grassed waterways are also needed in some areas.

A cropping system that includes wheat, grain sorghum, or other crops that produce a large amount of residue is well suited. Keeping the residue on the surface lessens crusting, controls wind erosion, and holds water until it soaks into the soil. After the critical period of wind

erosion in spring, the residue can be worked into the soil to improve the structure and tilth of the surface layer.

DRYLAND CAPABILITY UNIT IIIce-3

Portales clay loam, 0 to 1 percent slopes, is the only soil in this capability unit. It is a deep, calcareous soil of the High Plains. This soil has a subsoil of clay loam that is moderately permeable. The hazard of wind erosion is moderate. Natural fertility is moderate to high, but low rainfall limits yields most of the time.

This is a good soil for farming, and most of the acreage is cultivated. The soil is well suited to sorghum, small grains, cotton, and grass. Grain sorghum and winter wheat are the principal crops, but forage sorghum, oats, cotton, and barley are also grown on a small acreage. The main native grasses are blue grama and buffalograss.

Management of this soil includes controlling erosion, conserving moisture, and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, and emergency tillage. Field terraces, diversion terraces, contour farming, and grassed waterways are also needed in some areas.

A cropping system that includes grain sorghum, wheat, or other crops that produce a large amount of residue is well suited to this soil. The residue provides good control of erosion if it is kept on the surface. After the critical period of wind erosion in spring, the residue can be worked into the soil. Emergency tillage helps to control wind erosion in fields that do not have an adequate cover of plants or crop residue.

DRYLAND CAPABILITY UNIT IIIe-1

In this capability unit are deep, nearly level or gently sloping, clayey soils of the High Plains. These soils have a subsoil of blocky clay that is slowly permeable, and this tends to impede the movement of water, air, and roots. Natural fertility is high. The hazard of wind erosion is slight, and the hazard of water erosion is moderate. The soils in this unit are—

Pullman clay loam, 1 to 2 percent slopes.
Roscoe clay.

These soils are fairly good for farming, and most of the areas are cultivated. The soils are limited by their gentle slopes and by the dense, slowly permeable subsoil. They are well suited to sorghum, small grains, and grass. Grain sorghum and winter wheat are the principal crops. but forage sorghum, oats, and barley also are grown on a small acreage. The main native grasses are blue grama and buffalograss.

Management of these soils includes controlling erosion, conserving moisture, and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, emergency tillage, field terraces, and contour farming. Diversion terraces and grassed waterways are also needed in some areas.

A cropping system that includes wheat, grain sorghum, or other crops that produce a large amount of residue is well suited. Keeping the residue on the surface lessens crusting, controls wind erosion, slows runoff, and allows more water to soak into the soil. After the critical period of wind erosion in spring, the residue can be worked into the soil to improve the structure and tilth of the surface layer.

DRYLAND CAPABILITY UNIT IIIe-2

In this capability unit are deep, gently sloping clay loams that are on the High Plains and on the Rolling Plains below the High Plains. These soils have a subsoil of clay loam that has moderate to moderately slow permeability. The movement of air, moisture, and roots in the subsoil is fair to good. Natural fertility is high. The hazard of wind erosion is slight to moderate, and the hazard of water erosion is moderate. The soils in this unit are—

Bippus clay loam, 1 to 3 percent slopes.
Olton clay loam, 1 to 3 percent slopes.
Olton and Zita clay loams, 1 to 3 percent slopes.

These soils are used for cultivated crops and for range. They are good soils for farming, but they are limited by their gentle slopes that allow loss of some of the water through runoff. The Olton soils are also limited by the moderately slow rate at which they take in water. The soils of this unit are well suited to small grains, sorghum, cotton, and grass. Grain sorghum and winter wheat are the principal crops, but cotton, truck crops, forage sorghum, oats, and barley are also grown on a small acreage. The main native grasses are blue grama and buffalograss.

Management of these soils includes controlling erosion, conserving moisture, and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, emergency tillage, field terraces, contour farming, and stubble mulching. These practices conserve moisture and control erosion by slowing down runoff and by allowing more water to soak into the soils. Diversion terraces and grassed waterways are also needed in some areas.

A cropping system that includes wheat, grain sorghum, or other crops that produce a large amount of residue is well suited. After the critical period of erosion in spring, the residue can be worked into the soils to improve the structure and tilth of the surface layer. Emergency tillage can be used to control wind erosion in fields that have an inadequate cover of plants or crop residue.

DRYLAND CAPABILITY UNIT IIIe-3

Only Portales clay loam, 1 to 3 percent slopes, is in this capability unit. It is a deep, calcareous soil of the High Plains. This soil has a subsoil of moderately permeable clay loam. Natural fertility is moderate to high, but the soil is subject to moderate erosion by wind and water.

This is a fairly good soil for farming, but it is limited by its gentle slopes that allow loss of part of the water through runoff. It also contains a large amount of lime that causes chlorosis, or yellowing of the leaves, in some crops. This soil is well suited to small grains, sorghum, and grass, and most of the acreage is cultivated. Grain sorghum and winter wheat are the principal crops, and forage sorghum and barley are also grown on a small acreage. The main native grasses are blue grama and buffalograss.

Management of this soil includes controlling erosion, conserving moisture, and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good

management of crop residue, emergency tillage, field terraces, and contour farming. Diversion terraces and grassed waterways are also needed in some areas.

A cropping system that includes wheat, grain sorghum, or other crops that produce a large amount of residue is well suited. Keeping the residue on the surface helps to control erosion, slows runoff, and allows more water to soak in. Using stubble mulching to keep crop residue on the surface is beneficial. Emergency tillage helps to control wind erosion in fields that do not have an adequate cover of plants.

DRYLAND CAPABILITY UNIT IIIe-4

In this capability unit are deep, nearly level or gently sloping fine sandy loams. These soils are in rolling areas in the central and eastern parts of the county. They have a subsoil of sandy clay loam, clay loam, or fine sandy loam that is moderately permeable. Natural fertility is moderate to high. The hazard of wind erosion is moderate. There is a slight hazard of water erosion in the gently sloping areas. The soils in this unit are—

Bippus fine sandy loam, 1 to 3 percent slopes.
Miles fine sandy loam, 0 to 1 percent slopes.
Miles fine sandy loam, 1 to 3 percent slopes.
Spur and Guadalupe soils.

These soils are used for cultivated crops and grass. They are fairly good for farming, but they are limited mostly by the hazard of wind erosion. In some areas they are also limited by the gentle slopes that cause loss of some water through runoff. These soils are well suited to most of the crops grown in the area. Grain sorghum and cotton are the principal crops, but forage sorghum, winter wheat, oats, barley, rye, corn, alfalfa, and vegetables are also grown on a small acreage. The main native grasses are little bluestem, sideoats grama, and blue grama.

Management of these soils includes controlling erosion, conserving moisture, and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, and emergency tillage. Diversion terraces and grassed waterways are also needed in some areas. Field terraces and contour farming are needed in the gently sloping areas.

A cropping system that includes forage sorghum, grain sorghum, or other crops that produce a large amount of residue is well suited. Keeping the residue on the surface helps to control wind and water erosion and reduces evaporation. After the critical period of wind erosion in spring, the residue can be worked into the surface layer to improve the structure and tilth.

DRYLAND CAPABILITY UNIT IIIe-7

Only one soil, Mansker clay loam, 1 to 3 percent slopes, is in this capability unit. This soil is deep, has a weakly developed profile, and is calcareous. It occurs throughout most of the county. The subsoil is clay loam that is moderately permeable. Natural fertility is moderate to low. The hazard of wind erosion is slight, but the hazard of water erosion is slight to moderate.

This soil is used for cultivated crops and grass. It is a good soil for grass, but is only fairly good for cultivated crops. This soil is limited by its gentle slopes and high content of lime. Suitable crops are sorghum, small grains, and grass. Grain sorghum and winter wheat are the principal crops, but forage sorghum and barley are also grown on a small acreage. The main native grasses are sideoats grama, blue grama, and little bluestem.

Management of this soil includes controlling erosion, conserving moisture, and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, emergency tillage, field terraces, and contour farming. Diversion terraces and grassed waterways are also needed in some areas.

A cropping system that includes wheat, forage sorghum, or other crops that produce a large amount of residue is well suited. Keeping the residue on the surface helps to control wind erosion, slows runoff, and allows more water to soak into the soil. After the critical period of wind erosion in spring, the residue can be worked into the surface layer to improve the structure and tilth. Emergency tillage helps to control wind erosion in fields that do not have an adequate cover of plants.

DRYLAND CAPABILITY UNIT IVe-1

In this capability unit are deep, moderately sloping clay loams and loams below the margin of the High Plains. These soils have a subsoil of clay loam that has moderately slow permeability. Natural fertility is moderate to high. Wind erosion is a slight hazard, and water erosion is a moderately severe hazard. The soils in this unit are—

Olton clay loam, 3 to 5 percent slopes.
Olton loam, 3 to 5 percent slopes.

These are good soils for grass, but they are only fair for cultivated crops. Only a few areas are cultivated. The soils are limited mainly by losses of water through runoff on the moderate slopes and by the moderately slow rate at which they take in water. They are suited to sorghum, small grains, and grass, and forage sorghum, grain sorghum, and winter wheat are the principal crops. The main native grasses are blue grama and buffalograss.

Management of these soils includes controlling erosion, conserving moisture, and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, emergency tillage, field terraces, and contour farming. Diversion terraces and grassed waterways are needed in some areas.

A cropping system that includes wheat, forage sorghum, or other crops that produce a large amount of residue is well suited. Keeping the crop residue on the surface helps to control wind and water erosion, lessens crusting, slows runoff, and allows more water to soak into the soil. After the critical period of erosion in spring the residue can be worked into the surface layer to improve the tilth and structure. Care should be taken to avoid excessive tillage or tillage when the soil is wet. Excessive tillage or tilling when the soil is wet breaks down the soil structure and reduces the effectiveness of the crop residue.

DRYLAND CAPABILITY UNIT IVe-2

Mansker clay loam, 3 to 5 percent slopes, is the only soil in this capability unit. It is deep, but it is calcareous and has a zone of calcium carbonate near the surface. This soil occurs on and below the edge of the High Plains. It has a subsoil of moderately permeable clay

loam. Natural fertility is moderate to low. The hazard of wind erosion is slight, and the hazard of water erosion is moderate.

This is a good soil for grass, but it is fairly poor for crops. The moderate slopes, high content of lime, risk of erosion, and moderate to low fertility limit its use for crops, and only a moderate acreage is cultivated. Suitable crops are sorghum, small grains, and grass. Forage sorghum, grain sorghum, and winter wheat are the main cultivated crops, and blue grama, sideoats grama, and little bluestem are the main native grasses.

Management of this soil includes controlling erosion, conserving moisture, and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, emergency tillage, field terraces, and contour farming. Diversion terraces and grassed waterways are also needed in some areas.

A cropping system that includes wheat, forage sorghum, or other crops that produce a large amount of residue is well suited. Keeping the residue on the surface helps to control wind and water erosion, slows runoff, and allows more water to soak into the soil. After the critical period of wind erosion in spring, the residue can be worked into the surface layer to improve the tilth and structure. Emergency tillage helps to control wind erosion in fields that do not have an adequate cover of plants.

DRYLAND CAPABILITY UNIT IVe-4

The soils of this capability unit are deep, moderately sloping fine sandy loams that occur in the central and southeastern parts of the county. They have a subsoil of moderately permeable sandy clay loam and have moderate natural fertility. Some areas are eroded, and the hazard of further wind and water erosion is moderate. The soils in this unit are—

Miles fine sandy loam, 3 to 5 percent slopes.
Miles fine sandy loam, 3 to 5 percent slopes, eroded.

These soils are good for grass. They are marginal for field crops because they are limited by their moderate slopes and by the hazard of further erosion. They are suited to sorghum, small grains, cotton, and grass. Winter wheat and forage sorghum are the principal crops, but cotton, grain sorghum, barley, and oats are also grown on a small acreage. Little bluestem, blue grama, and sideoats grama are the main native grasses.

Management of these soils includes controlling erosion, conserving moisture, and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, emergency tillage, field terraces, and contour farming. Diversion terraces and grassed waterways are also needed in some areas.

A cropping system that includes wheat, forage sorghum, or other crops that produce a large amount of residue is well suited. Keeping the residue on the surface helps to control wind and water erosion, slows runoff, and allows more water to soak into the soil. One of the best ways of keeping the residue on the surface is drilling the wheat, forage sorghum, or other crops in closely spaced rows and stubble mulching the residue after the crop is harvested. After the critical period of wind erosion in spring, the residue can be worked into the surface layer to improve structure and tilth. Emergency tillage helps to control wind erosion in fields that do not have an adequate cover of plants.

DRYLAND CAPABILITY UNIT IVe-6

Only Miles loamy fine sand, 0 to 3 percent slopes, is in this capability unit. This deep soil is in the southeastern part of the county. It has a subsoil of moderately permeable sandy clay loam that can be penetrated readily by roots, water, and air. The surface layer has a low capacity for holding water and plant nutrients. Natural fertility is moderate. There is a slight hazard of water erosion in the gently sloping areas. The hazard of wind erosion is severe.

This soil is used for crops and grass. It is a good soil for grass, but it is fair to poor for cultivated crops. This soil is suited to most of the crops grown in the area. Cotton, grain sorghum, forage sorghum, and grass are grown on a large acreage each year. Vegetables, corn, cowpeas, rye, vetch, alfalfa, and fruit trees are grown on a small acreage. The native grasses are mainly switchgrass, indiangrass, little bluestem, sand bluestem, and sideoats grama. Sand sagebrush and shin oak grow in some areas.

Management includes controlling erosion and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, and emergency tillage. This soil needs to be deep plowed occasionally. The deep plowing increases the content of clay in the surface layer and thus increases resistance to wind erosion. Fertilizer is needed to increase yields and to increase the amount of residue produced. It should be applied according to the needs indicated by soil tests. Field terraces, diversion terraces, contour farming, and grassed waterways are also needed in some areas.

A cropping system that includes grain sorghum, forage sorghum, or other crops that produce a large amount of residue is well suited. Keeping the residue on the surface helps to control wind and water erosion. After the critical period of wind erosion in spring, the residue can be worked into the surface layer to improve the tilth and soil structure. Stubble mulching of crop residue and seeding the following crop in the stubble has proved to be beneficial. Emergency tillage helps to control wind erosion in fields that do not have an adequate cover of plants.

DRYLAND CAPABILITY UNIT IVe-10

Only one mapping unit, Mansker and Mobeetie fine sandy loams, 1 to 3 percent slopes, is in this capability unit. These soils are deep and calcareous, and they have a weakly developed profile. They are in the southeastern part of the county. The subsoil has a texture of clay loam to fine sandy loam and has moderate or moderately rapid permeability. Natural fertility is low. The soils are subject to moderate wind erosion and slight water erosion.

These soils are only fair for field crops and good for grass, but the acreage used for field crops and grass is about equal. The soils are limited for crops by their low fertility, high content of lime, gentle slopes, and the hazard of erosion. The crops to which they are suited

are sorghum, small grains, cotton, and grass. Forage sorghum and grain sorghum are the principal crops, but cotton, winter wheat, barley, and rye are grown on a small acreage. The main native grasses are little bluestem and sideoats grama.

Management of these soils includes controlling erosion, conserving moisture, and protecting the surface layer so that the structure does not deteriorate. Needed practices are a cropping system that conserves soil and water, good management of crop residue, emergency tillage, and contour farming. Field terraces, diversion terraces, and grassed waterways are also needed in some areas.

A cropping system that includes grain sorghum, forage sorghum, or other crops that produce a large amount of residue is well suited. Keeping the residue on the surface helps to control wind erosion, slows runoff, and allows more water to soak into the soil. After the critical period of wind erosion in spring, the residue can be worked into the surface layer to improve the structure and tilth. Emergency tillage helps to control wind erosion in fields that do not have an adequate cover of plants.

DRYLAND CAPABILITY UNIT IVe-11

Only Springer loamy fine sand, undulating, is in this capability unit. This is a deep soil that occurs in the southeastern part of the county. Its subsoil has a texture of fine sandy loam that has moderately rapid permeability; water, air, and roots move readily through it. Natural fertility is low, and this soil is highly susceptible to wind erosion.

This is a good soil for grass, but it is poor for crops, and only a few areas are cultivated. This soil is limited by its sandy texture and by droughtiness, but it is suited to sorghum and grass. Forage sorghum and grain sorghum are the principal crops, but alfalfa, cotton, vegetables, cowpeas, rye, and fruit trees are also grown on a small acreage. The main native grasses are switchgrass, indiangrass, little bluestem, sand bluestem, and sideoats grama. Also, sand sagebrush and shin oak grow in some areas.

Management of this soil involves controlling erosion and protecting the surface layer so that the structure does not deteriorate. Needed practices include a cropping system that conserves soil and water, good management of crop residue, emergency tillage, and growing closely spaced cultivated crops, grasses, or legumes. Also, fertilizer should be applied according to the needs indicated by the results of soil tests. The fertilizer increases yields and also increases the amount of residue produced.

A cropping system that includes forage sorghum, grain sorghum, or other crops that produce a large amount of residue is well suited. Keeping the residue on the surface helps to control wind erosion. The residue should be kept on the surface as long as feasible and then should be worked into the surface layer to improve the tilth and soil structure.

DRYLAND CAPABILITY UNIT Vw-2

Only one mapping unit, Lincoln soils, is in this capability unit. These are deep, sandy, calcareous soils that have moderately rapid permeability. They are on the flood plains of most of the streams in the county and are subject to flooding. These soils are highly susceptible to wind erosion. The water table is within a few feet of the surface in many areas.

These are good soils for grass, but they are not suitable for cultivation, because they are sandy and subject to flooding. They are used mostly for range or for growing hay. The main native grasses are sand bluestem, little bluestem, switchgrass, indiangrass, and sideoats grama. Sedges, cattails, alkali sacaton, and saltcedar grow in the lower lying areas, and sand sagebrush grows in some of the higher areas. Scattered willow and cottonwood trees also grow in some places. The areas in range provide some food and cover for wildlife.

Management of these soils includes controlling erosion and maintaining or increasing the stand and vigor of the tall and mid native grasses. Needed practices are protecting the range by deferring grazing and distributing livestock more evenly.

A grazing or mowing plan in which half of each year's growth of grass is grazed or mowed annually is well suited to these soils. This helps to maintain a vigorous stand of grass that will control erosion. Bare areas and areas that have been overgrazed should be reseeded to a mixture of native grasses, and grazing ought to be deferred for at least one season. Woody plants can be controlled by spraying with chemicals. After the brush has been controlled, grazing should be deferred for a time for best results. More information about managing these soils for range is given under the description of the Sandy Bottomland range site in the section "Use of the Soils for Range."

DRYLAND CAPABILITY UNIT Vw-3

Only one mapping unit, Sweetwater soils, is in this capability unit. These are dark, loamy, nearly level, poorly drained soils that have a mottled, sandy subsoil. They formed in alluvium on the flood plains of the major streams. The soils are permanently wet and are subject to occasional flooding. The water table is within 2 feet of the surface.

These soils are too wet for cultivation and can be used only for hay or range. They are among the most productive soils used for grass in this county. The growth of the roots of some grasses, however, is limited by the high water table. The main native grasses on these soils are switchgrass, indiangrass, eastern gamagrass, sideoats grama, sand bluestem, and alkali sacaton. Sedges, rushes, and cottonwood trees also grow on these soils. The areas in range provide some food and cover for wildlife.

Management of these soils includes control of grazing or mowing to maintain or increase the stand of tall and mid native grasses. Needed practices are protecting the range by deferring grazing and distributing livestock more evenly. Management practices needed for the areas in hay are those that restrict the height and frequency of mowing. The grasses should be allowed enough time to recover their vigor before the next mowing or before frost.

Management of grazing or mowing so that about half of each year's growth of grass is grazed or mowed annually is well suited to these soils. This practice helps to maintain a vigorous stand of grass. More information about managing these soils for range is given under the

description of the Loamy Bottomland range site in the section "Use of the Soils for Range."

DRYLAND CAPABILITY UNIT VIe-2

The soils in this capability unit are deep, gently sloping to sloping loams, clay loams, and very fine sandy loams. These soils are limy to the surface and have moderately rapid permeability in their surface layer. Their subsoil is moderately permeable loam or clay loam. Some of these soils have only weakly defined layers. The hazard of wind erosion is slight, and the hazard of water erosion is severe. Natural fertility is moderate to low. The soils in this unit are—

Mansker clay loam, 5 to 8 percent slopes.
Mansker-Potter complex, 3 to 12 percent slopes (Mansker soil only).
Potter-Berthoud-Mansker complex, 5 to 20 percent slopes (Berthoud and Mansker soils only).
Woodward-Quinlan complex, 5 to 50 percent slopes.

These soils are used extensively for range, but the steep slopes make them unsuitable for cultivation. They are fairly good soils for grass but are limited by their susceptibility to erosion and by the loss of water through runoff. The native grasses are mostly blue grama, sideoats grama, and little bluestem. The areas of range also provide some food and cover for wildlife.

Management of these soils includes controlling erosion and maintaining or increasing the stand and vigor of the native mid and short grasses. Needed practices are protecting the range by deferring grazing and by distributing livestock more evenly.

A grazing plan in which about half of each year's growth of grass is grazed annually is well suited to these soils. This practice helps to maintain a vigorous stand of grass that increases the intake of water, reduces runoff, and helps to control erosion. Bare areas, areas that have been overgrazed, and some abandoned fields should be reseeded to a mixture of native grasses, and grazing should be deferred for at least one season. More information about managing these soils for range is given under the description of the Hardland Slopes and Mixedland range sites in the section "Use of the Soils for Range."

DRYLAND CAPABILITY UNIT VIe-3

In this capability unit are deep, moderately sloping to sloping fine sandy loams. These soils are limy to the surface. They have a subsoil of fine sandy loam or clay loam that has moderate to moderately rapid permeability. Natural fertility is moderate to low. The hazard of wind erosion is moderate, and the hazard of water erosion is moderately severe. The soils in this unit are—

Mobeetie fine sandy loam, 3 to 8 percent slopes.
Mobeetie-Mansker-Potter complex, 3 to 12 percent slopes (Mobeetie and Mansker soils only).

These soils are too steep for cultivation and are used extensively for range. They are fairly good for grass but are limited by the hazard of erosion and by losses of water through runoff. The native grasses on these soils are mainly sideoats grama, little bluestem, and blue grama. Yucca and sand sagebrush also grow in some areas. The areas in range provide some food and cover for wildlife.

Management of these soils includes controlling erosion and maintaining or increasing the stand and vigor of the native grasses. Needed practices are protecting the range by deferring grazing and distributing livestock more evenly.

A grazing plan in which about half of each year's growth of grass is grazed is well suited to these soils. This practice helps to maintain a vigorous stand of grasses that will increase the intake of water, reduce runoff, and help to control erosion. Bare areas, areas that have been overgrazed, and some abandoned fields should be reseeded to a mixture of native grasses, and grazing should be deferred for at least one season. For best results, chemical spraying of brush should be followed by a period in which grazing is deferred. More information about managing these soils for range is given under the description of the Mixedland Slopes range site in the section "Use of the Soils for Range."

DRYLAND CAPABILITY UNIT VIe-6

The soils in this capability unit are deep, nearly level to moderately sloping or hummocky loamy fine sands and fine sands. Their subsoil has moderate to moderately rapid permeability. Some of these soils are limy to the surface, and some are eroded. Natural fertility is low. The hazard of wind erosion is high, and the hazard of water erosion is moderate in the moderately sloping and hummocky areas that have been cultivated or that are already eroded. The soils in this unit are—

Likes loamy fine sand, 3 to 8 percent slopes.
Miles loamy fine sand, 3 to 5 percent slopes.
Miles and Brownfield soils, 3 to 5 percent slopes, eroded.
Springer loamy fine sand, hummocky.
Tivoli complex.

The soils of this unit are better suited to grass than to cultivated crops because the moderate slopes, sandy texture, and droughtiness limit their use for cultivated crops. They are used extensively for range. The main native grasses are sand bluestem, switchgrass, little bluestem, indiangrass, and sideoats grama. Woody plants that grow in some areas are sand sagebrush, shin oak, wild plum, and skunkbush. The areas in range provide some food and cover for wildlife.

Management of these soils includes control of erosion and maintaining or increasing the stand and vigor of the tall and mid native grasses. Needed practices are protecting the range by deferring grazing and distributing livestock more evenly.

A grazing plan in which about half of each year's growth of grass is grazed is well suited to these soils. This practice helps to maintain a vigorous stand of grass that will increase the intake of water, reduce runoff, and control erosion. Chemical spraying of brush has proved to be the quickest and most practical way of controlling undesirable woody plants in large areas. For best results, after the brush has been controlled, grazing should be deferred for a time. Bare areas and areas that have been overgrazed should be reseeded to a mixture of native grasses, and grazing ought to be deferred for at least one season. More information about management of these soils for range is given under the description of the Sandyland range site in the section "Use of the Soils for Range."

DRYLAND CAPABILITY UNIT VIs-1

Only Hilly gravelly land is in this capability unit. This land type consists of sandy and moderately sandy soil material on gravelly ridges and knobs. The high content of gravel and sand in the areas limits the capacity to hold moisture and plant nutrients. Water enters the soil material readily, and the loss of water through runoff is moderate to low. The hazard of wind erosion is slight, but the hazard of water erosion is moderate.

Areas of this land type are used extensively for range. They are too steep and gravelly for cultivation but are fairly good for grass. They are limited by the high content of gravel and sand. The main native grasses are sideoats grama, little bluestem, sand bluestem, hairy grama, and three-awn, and the main woody plants are sand sagebrush and skunkbush. The areas in range provide some food and cover for wildlife. Also, small areas are used as a commercial source of sand and gravel.

Management of this land type includes controlling erosion and maintaining or increasing the stand and vigor of the mid and tall native grasses. Needed practices are protecting the range by deferring grazing and distributing livestock more evenly.

A grazing plan in which about half of each year's growth of grass is grazed each year is well suited. This helps to maintain a vigorous stand of grass that increases the intake of water, reduces runoff, and helps to control erosion. For best results, chemical spraying of brush should be followed by a period in which grazing is deferred. Abandoned gravel pits should be shaped and reseeded to a mixture of native grasses. Also, grazing ought to be deferred for one season or more to return the areas to productive use. More information about management of this land type for range is given under the description of the Gravelly range site in the section "Use of the Soils for Range."

DRYLAND CAPABILITY UNIT VIw-1

Randall clay, a deep soil, is the only mapping unit in this capability unit. It has a subsoil of dense clay that is very slowly permeable. This soil occupies the beds of intermittent lakes, or playas, on the High Plains. These playas receive runoff from the surrounding areas and are flooded in most years for several months at a time. Soil blowing is a hazard when the playas are dry.

This soil is generally not safe for the production of crops. It is used mainly for pasture made up of native rushes and sedges and as a refuge for wildlife. In years of below-normal rainfall, some of the smaller, shallower lakes are farmed or grazed. Western wheatgrass and buffalograss become temporarily established on the bottom of the playas, but these are drowned out when rain fills the playas. In wet seasons water is impounded in the larger playas for a long period. These areas provide food and cover for ducks, geese, and other migratory game birds.

Management includes controlling erosion when this soil is dry and controlling water when the soil is flooded. Emergency tillage is needed to control wind erosion when the lakebed is dry. Water from a few of these lakes can be used to irrigate nearby cropland, but the lakes are an unreliable source of irrigation water and of water for livestock. The digging of a pit-type pond increases the length of time that a lake can be used as a source of water for livestock.

DRYLAND CAPABILITY UNIT VIIe-1

Only Tivoli fine sand is in this capability unit. It is a deep soil on dunes adjacent to the larger streams. It is mostly in the eastern part of the county. This soil has low natural fertility. It takes in water rapidly, and little runs off. The hazard of wind erosion is severe.

This soil is used for range, but its use is limited by the sandy texture, droughtiness, and severe hazard of erosion.

The main native grasses are sand bluestem, indiangrass, switchgrass, little bluestem, big sandreed, and sideoats grama. Sand sagebrush, wild plum, shin oak, and skunkbush are the woody plants that grow in most areas. The areas in range also provide some food and cover for wildlife.

Management of this soil includes controlling erosion and maintaining or increasing the stand and vigor of the tall and mid native grasses. Needed practices consist of protecting the range by deferring grazing, distributing livestock more evenly, and establishing grass on the bare areas.

A grazing plan in which about half of each year's growth of grass is grazed is well suited to this soil. This practice helps to maintain a vigorous stand of grass that will help to control erosion. All economically feasible means should be used to establish a stand of native grasses on the bare areas. A good stand of grass prevents sand from being deposited on the more productive areas. It is essential that a period of deferment follow measures used for brush control. This allows the native grasses to recover and grow, and it protects the soil from erosion. More information about use of this soil for range is given under the description of the Deep Sand range site in the section "Use of the Soils for Range."

DRYLAND CAPABILITY UNIT VIIs-1

The soils of this unit are very shallow over caliche. They extend along the caprock below the edge of the High Plains. These soils have a limited capacity to hold moisture and plant nutrients. The loss of water from runoff is high because the slopes are steep and the vegetation over most of the area is sparse. The soils in this unit are—

- Mansker-Potter complex, 3 to 12 percent slopes (Potter soil only).
- Mobeetie-Mansker-Potter complex, 3 to 12 percent slopes (Potter soil only).
- Potter-Berthoud-Mansker complex, 5 to 20 percent slopes (Potter soil only).

These soils are used extensively for range, but they are limited by the caliche near the surface and by the severe hazard of erosion. The main native grasses are sideoats grama, little bluestem, three-awn, and hairy grama. Some catclaw, yucca, and redberry juniper also grow in some places. The areas in range provide some cover and food for wildlife.

Management of these soils includes controlling erosion and maintaining or increasing the stand and vigor of the native grasses. Needed practices are protecting the range by deferring grazing and distributing livestock more evenly. Management of these soils is made more difficult because they are in soil complexes.

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A grazing plan in which about half of each year's growth of grass is grazed is well suited to these soils. This practice helps to maintain a vigorous stand of grass that reduces runoff, increases the intake of water, and helps to control erosion. More information about the use of these soils for range is given under the Very Shallow range site in the section "Use of the Soils for Range."

DRYLAND CAPABILITY UNIT VIIs-2

Only Rough broken land in this capability unit. This land type is made up of loamy areas that have little or no soil material. Runoff is very rapid, and the hazard of water erosion is very severe. There are gullies and receding escarpments in many areas, and the wearing away of these areas continues.

This land type is used extensively for range, but the outcrops of hard caliche and loamy calcareous material support only a thin stand of plants. Therefore, the land has only limited value for grazing. Most of the grass grows in small pockets of soil material that occur on benches, but production of forage is low. The main native grasses are sideoats grama and little bluestem. Scattered catclaw, yucca, and redberry juniper also grow in most areas.

Managing this land type includes controlling erosion and maintaining or increasing the stand and vigor of the native grasses. Needed practices are protecting the range by deferring grazing and distributing livestock more evenly.

A grazing plan in which about half the growth of grass is grazed each year is well suited to this land type. This practice helps to maintain a vigorous stand of grass that will reduce runoff, increase the intake of water, and help to control erosion. Wells powered by windmills are used to provide water for livestock in many areas. Reservoirs for storing water fill rapidly with silt from watersheds in these areas. Also, stable sites for spillways are generally difficult to locate. Dams and spillways near stock tanks can be protected from erosion by seeding the areas to native grasses and, if necessary, by fencing. More information about the use of this land type for range is given under the Rough Broken range site in the section "Use of the Soils for Range."

DRYLAND CAPABILITY UNIT VIIIe-2

Only one mapping unit, Badland, is in this capability unit. This land type consists of a small amount of soil material in steep, nearly bare, eroding areas. These areas are scattered mainly throughout the southeastern part of the county. They are small and are actively eroding into the calcareous material of the Ogallala formation. The losses of water through runoff are extremely high.

These areas have little value for agriculture. They are suitable for wildlife, and for esthetic uses.

Management includes the use of any economically feasible means to stabilize the areas by establishing a cover of trees, shrubs, or grass. Fences are needed to keep out livestock. They allow the few existing grasses to increase in size and increase the number of wildlife in the area. Diversion terraces above these areas turn water away and slow the progress of head cuts. The large amount of silt produced in these areas should be considered when planning and designing structures below them. Raw, calcareous, loamy material washes down from the bare slopes and damages areas downstream. This land type is not suitable for range and is not assigned to a range site.

Management of irrigated soils

Irrigation was begun in this county in the late forties. The number of irrigation wells and the acreage of irrigated crops have increased since that time. Surface irrigation systems are the most common type used on the nearly level, moderately fine textured soils of the High Plains. They are the level furrow, graded furrow, level border, and graded border systems.

A sprinkler system is most commonly used to irrigate the sandy soils, such as the Miles loamy fine sands in the central and southeastern parts of the county. The design of the system is based on the rate of intake, on the permeability and water-holding capacity of the soils, and on the supply of available water. The main practices needed for irrigated soils are a cropping system that conserves soil and water, good management of crop residue, and maintaining fertility. The irrigated capability units in this county are discussed in the following pages.

IRRIGATED CAPABILITY UNIT I-2

This capability unit consists of deep, nearly level clay loams and loams of the High Plains and Rolling Plains and on bottom lands. These soils have a subsoil of clay loam that has moderate to moderately slow permeability. They take in water readily and are easily managed to maintain the intake and the movement of water. Water, air, and roots penetrate these soils readily, and fertility and the water-holding capacity are moderate to high. The hazard of wind erosion is slight to moderate. The soils in this unit are—

Olton loam, 0 to 1 percent slopes.
Olton and Zita clay loams, 0 to 1 percent slopes.
Spur clay loam.

Winter wheat and grain sorghum are the principal crops grown on these soils, but alfalfa, cotton, and forage sorghum are also grown. Midland bermudagrass, switchgrass, and indiangrass are the principal pasture plants.

Proper use of irrigation water through use of a surface or sprinkler irrigation system, returning a large amount of crop residue to the soils, and maintaining fertility are needed practices. Such crops as sorghum and wheat provide a cover of growing plants and enough residue to protect the soils when wind erosion and water erosion are most likely to be critical. Diversion terraces and grassed waterways are needed to control erosion where runoff is excessive.

IRRIGATED CAPABILITY UNIT I-4

Only one mapping unit, Spur and Guadalupe soils, is in this capability unit. These are deep, nearly level fine sandy loams on bottom lands in the central part of the county. They have a subsoil of clay loam or fine sandy loam that is moderately permeable. The movement of air, moisture, and roots in the subsoil is good. Natural fertility is high.

Only a few areas of these soils are irrigated; some of the areas are flooded occasionally, but the floodwaters recede within a few hours. Cotton and alfalfa are the principal crops, but grain sorghum, forage sorghum, vegetables, and winter wheat are also grown. Midland

bermudagrass, switchgrass, and indiangrass are the principal pasture plants.

Proper use of irrigation water through use of a surface or sprinkler irrigation system, returning a large amount of crop residues to the soil, and maintaining fertility are needed practices. Such crops as alfalfa and sorghum provide a cover of growing plants and enough residue to protect the soils when wind erosion and water erosion are likely to be critical. Diversion terraces and grassed waterways are needed to control erosion where runoff is excessive.

IRRIGATED CAPABILITY UNIT IIe-1

The soils in this capability unit are gently sloping clay loams on the High Plains and in the area of the Rolling Plains adjacent to the High Plains. They have a subsoil of clay loam that has moderately slow to moderate permeability. The movement of air, moisture, and roots in the subsoil is fair to good. The capacity to hold water and plant nutrients is high. The hazard of wind erosion is slight, and the hazard of water erosion is moderate. The soils in this unit are—

Olton clay loam, 1 to 3 percent slopes.
Olton and Zita clay loams, 1 to 3 percent slopes.

Winter wheat and grain sorghum are the principal crops grown on these soils, but alfalfa and forage sorghum are also grown. Midland bermudagrass, switchgrass, and indiangrass are the principal pasture plants.

Proper use of irrigation water through use of a surface irrigation system, returning a large amount of crop residue to the soil, and maintaining fertility are needed practices. Field terraces and grassed waterways are needed to control erosion where runoff is excessive. Such crops as sorghum and wheat provide a cover of growing plants and enough residue to protect the soils when wind erosion and water erosion are most likely to be critical.

IRRIGATED CAPABILITY UNIT IIe-2

The soils in this capability unit are deep, gently sloping clay loams and loams that are below the High Plains. These soils have a subsoil of clay loam that has moderate or moderately slow permeability. They take in water readily and are easily managed. The capacity to hold water and plant nutrients is moderate to high. Wind erosion is a slight to moderate hazard, and water erosion is a moderate hazard. The soils in this unit are—

Bippus clay loam, 1 to 3 percent slopes.
Olton loam, 1 to 3 percent slopes.

Grain sorghum and winter wheat are the principal crops on these soils, but alfalfa, cotton, corn, and forage sorghum are also grown. Midland bermudagrass, switchgrass, and indiangrass are the principal pasture plants.

Proper use of irrigation water through the use of a surface or sprinkler irrigation system, returning a large amount of crop residue to the soil, and maintaining fertility are needed practices. Such crops as sorghum and wheat provide a cover of growing plants and enough residue to protect the soils when wind erosion and water erosion are likely to be critical. Field terraces and grassed waterways are needed to control erosion where runoff is excessive.

IRRIGATED CAPABILITY UNIT IIe-3

Portales clay loam, 0 to 1 percent slopes, is the only soil in this capability unit. This is a deep soil of the High Plains. It has a subsoil of clay loam that is moderately permeable. This soil is calcareous to the surface in most places. Its capacity to hold water and plant nutrients is moderate. There is a moderate hazard of wind erosion.

Grain sorghum and winter wheat are the principal crops on this soil, but forage sorghum is also grown. Midland bermudagrass, switchgrass, and indiangrass are the principal pasture plants.

Proper use of irrigation water through the use of a surface or sprinkler irrigation system, returning a large amount of crop residue to the soil, and maintaining fertility are needed practices. Diversion terraces and grassed waterways are needed to control erosion where runoff is excessive. Such crops as sorghum and wheat provide a cover of growing plants and enough residue to protect the soil where wind erosion and water erosion are likely to be critical.

IRRIGATED CAPABILITY UNIT IIe-4

Only Miles fine sandy loam, 0 to 1 percent slopes, is in this capability unit. This is a deep soil that occurs in the southeastern part of the county. It has a moderately permeable subsoil of sandy clay loam. The movement of air, moisture, and roots in this layer is good. Natural fertility is high. The hazard of wind erosion is slight.

Only a few areas of this soil are irrigated. Grain sorghum and cotton are the principal crops, and alfalfa, winter wheat, and forage sorghum are also grown. Midland bermudagrass, switchgrass, and indiangrass are the principal pasture plants.

Proper use of irrigation water through the use of a surface or sprinkler irrigation system, returning a large amount of crop residue to the soil, and maintaining fertility are needed practices. Such crops as sorghum and wheat provide a cover of growing plants and enough residue to protect the soil when wind erosion and water erosion are likely to be critical. Diversion terraces and grassed waterways are needed to protect some areas and to control erosion where runoff is excessive.

IRRIGATED CAPABILITY UNIT IIe-5

In this capability unit are deep, gently sloping fine sandy loams that occupy rolling areas in the central and southeastern parts of the county. These soils have a moderately permeable subsoil of sandy clay loam to clay loam. The hazard of erosion by wind and water is slight. The soils in this unit are—

Bippus fine sandy loam, 1 to 3 percent slopes.
Miles fine sandy loam, 1 to 3 percent slopes.

These soils produce moderate to high yields under irrigation if good management is used. Cotton and grain sorghum are the principal crops, but alfalfa, forage sorghum, and winter wheat are also grown. Midland bermudagrass, switchgrass, and indiangrass are the principal pasture plants.

Proper use of irrigation water through the use of a surface or sprinkler irrigation system, returning a large amount of crop residue to the soil, and maintaining fertility are needed practices. Such crops as sorghum and alfalfa provide a cover of growing plants and enough residue to protect the soils when wind erosion and water erosion are likely to be critical. Field terraces and

grassed waterways are needed to control erosion where runoff is excessive.

IRRIGATED CAPABILITY UNIT IIs-1

In this capability unit are deep, nearly level clay loams and clays that occur throughout the High Plains. These soils have a clayey subsoil that is slowly permeable. This dense subsoil limits the development of roots and impedes the movement of air and water. The capacity to hold water and plant nutrients is high. Wind erosion is a slight hazard. The soils in this unit are—

Pullman clay loam, 0 to 1 percent slopes.
Roscoe clay.

Winter wheat and grain sorghum are the principal crops on these soils, but alfalfa, cotton, and forage sorghum are also grown. Midland bermudagrass, switchgrass, and indiangrass are the principal pasture plants.

Proper use of irrigation water through use of a surface irrigation system, returning a large amount of crop residue to the soil, and maintaining fertility are needed practices. Diversion terraces and grassed waterways are also needed to control erosion where runoff is excessive. Such crops as sorghum and wheat provide a cover of growing plants, and enough residue to protect the soils when wind erosion and water erosion are likely to be critical.

IRRIGATED CAPABILITY UNIT IIIe-1

Only Pullman clay loam, 1 to 2 percent slopes, is in this capability unit. This is a deep soil of the High Plains. It has a clayey subsoil that limits the development of roots and impedes the movement of air and water. The capacity to hold water and plant nutrients is high. The hazard of wind erosion is slight, and the hazard of water erosion is moderate.

Winter wheat and grain sorghum are the principal crops grown on this soil, but alfalfa and forage sorghum are also grown. Midland bermudagrass, switchgrass, and indiangrass are the principal pasture plants.

Proper use of irrigation water through the use of a surface irrigation system, returning a large amount of crop residue to the soils, and maintaining fertility are needed practices. Such crops as sorghum and wheat provide a cover of growing plants and enough residue to protect the soils when wind erosion and water erosion are likely to be critical. Field terraces and grassed waterways are needed to control erosion where runoff is excessive.

IRRIGATED CAPABILITY UNIT IIIe-3

Only Miles fine sandy loam, 3 to 5 percent slopes, is in this capability unit. This soil occurs in rolling areas in the central and southeastern parts of the county. It is deep and moderately sloping. The subsoil is moderately permeable sandy clay loam; air, moisture, and roots move through it readily. The hazard of water erosion is moderate, but the hazard of wind erosion is slight.

Only a few areas of this soil are irrigated, and the principal crops in the irrigated areas are grain sorghum and winter wheat. Cotton and forage sorghum are also grown, and midland bermudagrass, switchgrass, and indiangrass are the main pasture plants. Even under careful management, yields are only moderate.

Proper use of irrigation water through use of a surface or sprinkler irrigation system, returning a large amount of crop residue to the soil, and maintaining fertility are needed practices. Such crops as sorghum and wheat provide a cover of growing plants and also enough residue to protect the soil when wind erosion and water erosion are most likely to be critical. Field terraces and grassed waterways are needed to control erosion where runoff is excessive.

IRRIGATED CAPABILITY UNIT IIIe-4

Only one soil, Portales clay loam, 1 to 3 percent slopes, is in this capability unit. It is a deep soil of the High Plains. The subsoil is clay loam that is moderately permeable. This soil is calcareous to the surface in most places. Its capacity to hold water and plant nutrients is moderate. The hazard of erosion by wind and water is moderate.

Only a few areas of this soil are irrigated. Grain sorghum and winter wheat are the principal crops, but some forage sorghum is grown. Midland bermudagrass, switchgrass, and indiangrass are the principal pasture plants.

Proper use of irrigation water through use of a surface or sprinkler irrigation system, returning a large amount of crop residue to the soil, and maintaining fertility are needed practices. Such crops as sorghum and wheat provide a cover of growing plants and enough residue to protect the soil when wind erosion and water erosion are likely to be critical. Field terraces and grassed waterways are needed to control erosion where runoff is excessive.

IRRIGATED CAPABILITY UNIT IIIe-6

Miles loamy fine sand, 0 to 3 percent slopes, is the only soil in this capability unit. This is a deep soil on broad, undulating ridges in the southeastern part of the county. It has a subsoil of sandy clay loam that is moderately permeable. The hazard of wind erosion is moderate. The hazard of water erosion is slight in the gently sloping areas.

Only a small acreage of this soil is irrigated. The fields are generally small, and the supply of water is sometimes limited. Under good management, yields are moderate. Grain sorghum and cotton are the principal crops, but alfalfa, winter wheat, rye, and forage sorghum are also grown. Midland bermudagrass, switchgrass, and indiangrass are the principal pasture plants.

Proper use of irrigation water through use of a sprinkler irrigation system, keeping a large amount of crop residue on the surface and then returning it to the soil, and maintaining fertility are needed practices. Such crops as sorghum and alfalfa provide a cover of growing plants and enough residue to protect the soil from wind and water erosion. When no crop is growing, crop residue or a mulch should be kept on the surface to protect the soil from blowing. Diversion terraces and grassed waterways are needed to control erosion where runoff is excessive.

IRRIGATED CAPABILITY UNIT IIIe-7

The soils in this unit are deep, gently sloping, calcareous clay loams and fine sandy loams that are scattered throughout the county. They have a subsoil of clay loam to fine sandy loam that has moderate to moderately rapid permeability. These soils take water readily, but their capacity to hold moisture is limited. The

hazard of water erosion is slight to moderate, and the hazard of wind erosion is slight. The soils in this unit are—

Mansker clay loam, 1 to 3 percent slopes.
Mansker and Mobeetie fine sandy loams, 1 to 3 percent slopes.

Only a few areas of these soils are irrigated. Grain sorghum and winter wheat are the principal crops, but cotton and forage sorghum are also grown. Midland bermudagrass, switchgrass, and indiangrass are the principal pasture plants.

Proper use of irrigation water through use of a surface or sprinkler irrigation system, returning a large amount of crop residue to the soil, and maintaining fertility are needed practices. Field terraces and grassed waterways are needed to control erosion where runoff is excessive. Such crops as sorghum and wheat provide a cover of growing plants and enough residue to protect the soils when wind erosion and water erosion are likely to be critical.

IRRIGATED CAPABILITY UNIT IVe-2

Only one soil, Miles loamy fine sand, 3 to 5 percent slopes, is in this capability unit. This is a deep soil in the southeastern part of the county. It has a subsoil of sandy clay loam that is moderately permeable. The hazard of erosion by both wind and water is moderate.

Only a few areas of this soil are irrigated, and yields are low to moderate where good management is practiced. Alfalfa and improved strains of native grasses are the main crops, but some grain sorghum, forage sorghum, and small grains are grown. Midland bermudagrass, indiangrass, and switchgrass are the principal pasture plants.

Proper use of irrigation water through use of a sprinkler irrigation system, keeping a large amount of crop residue on the surface and then returning it to the soil, and maintaining fertility are needed practices. Alfalfa and grasses provide a cover of growing plants and enough residue to protect the soils from wind and water erosion. Where no crop is growing, crop residue or a mulch should be kept on the surface to protect the soil from blowing. Diversion terraces and grassed waterways are needed to control erosion where runoff is excessive.

IRRIGATED CAPABILITY UNIT IVe-3

In this capability unit are deep, undulating to hummocky loamy fine sands on broad ridges in the southeastern part of the county. These soils have a subsoil of fine sandy loam that has moderately rapid permeability. They have a moderate to severe hazard of wind erosion. Water is taken in rapidly, but the capacity of the soils to hold water and plant nutrients is moderate to low. The soils in this unit are—

Springer loamy fine sand, undulating.
Springer loamy fine sand, hummocky.

Only a small acreage of these soils is irrigated. The irrigated fields are generally small, and the supply of water is sometimes limited. Grass and alfalfa are the principal irrigated crops, but grain sorghum, forage sorghum, vegetables, fruits, cotton, and small grains are also grown. Indiangrass, switchgrass, and midland bermudagrass are the main pasture plants. Even under good management, yields are moderate to low.

Such practices as using irrigation water properly through use of a sprinkler irrigation system, keeping a large amount of crop residue on the surface, and then returning crop residue to the soil are always needed. Practices that maintain fertility are also required. The alfalfa and grass provide a growing cover and enough residue to protect the soils from erosion by wind and water. When crops are not growing on these soils, crop residue or a mulch should be kept on the surface to provide protection from blowing. Diversion terraces and grassed waterways are needed to control erosion where runoff is excessive.

Predicted Average Yields [3]

Table 3 gives the predicted average yields per acre, under dryland and irrigated farming, for the principal crops grown in the county. The yields are shown for two levels of management. Yields to be expected under the average level of management are shown in columns A, and those to be expected under a high level of management are shown in columns B. These are the average yields that can be expected over a period of years. They are based on information obtained from research and from interviews with farmers and other persons who have knowledge about the soils. Other crops than those named are grown in the county, but they are not grown on a large acreage and reliable yield data are not available.

Under average management, the following practices are used on dryland:

1. Water from precipitation is not properly conserved.
2. Crop residue is improperly managed.
3. Tillage alone is used to control wind erosion.
4. The soil is needlessly packed when it is wet, or it is pulverized by excessive tillage.

Under average management, the following practices are used on irrigated soils:

1. Irrigation water is not conserved.
2. Little or no extra effort is made to save and use water from rainfall.
3. Irrigation water is applied erratically in relation to the needs of the crop.
4. Crop residue is improperly managed.
5. Tillage alone is used to control wind erosion.
6. Fertilizer is not used or is applied haphazardly.
7. The soils are plowed when wet.
8. The length of the slope and the kind of soil are not considered when determining frequency with which water should be applied and the amount to apply.

Under a high level of management, all of the following practices are used on dryland:

1. Rainfall is conserved.
2. Measures needed to control water erosion are applied.
3. Crop residue is properly managed.
4. Minimum, but timely, stubble-mulch tillage is used to prevent breakdown of the soil structure, to control weeds, and to prepare the seedbed.

[3] By JACK G. DOUGLAS, management agronomist, Soil Conservation Service.

5. Weeds, insects, and diseases are controlled.
6. High-quality seed of adapted varieties is used.

Under a high level of management, all of the following practices are used on irrigated soils:

1. Rainfall is conserved and used.
2. Irrigation water is applied according to the needs of the crop.
3. Crop residue is used to control erosion by wind and water.
4. Fertilizer is applied according to the needs of the crop, as determined by chemical analysis of the soils.
5. Soil-improving crops and crops that produce a large amount of residue are included in the cropping system.
6. The soils are not tilled when wet.
7. The length and degree of the slope are considered when planning the length of the irrigation run and when applying water.

Windbreaks

Only a few trees are native to Gray County, and these grow mainly on bottom lands occupied by Spur, Guadalupe, Lincoln, and Sweetwater soils. The other trees in

Table 3.—*Predicted average yields per acre of the principal dryland and irrigated crops grown on arable soils under two levels of management*

[Yields in columns A are those obtained over a period of years under average management; yields in columns B are those to be expected under improved management. Absence of a yield figure indicates that the crop is generally not grown on the soil or that the crop is not commonly grown under the type of management indicated]

Soil	Wheat				Cotton (lint)				Grain sorghum				Forage sorghum				Alfalfa	
	Dryland		Irrigated		Dryland		Irrigated		Dryland		Irrigated		Dryland		Irrigated		Irrigated	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Bippus clay loam, 1 to 3 percent slopes	12	14	35	50	150	175	500	800	15	21	65	100	1. 5	1. 75	9	16	3. 2	5. 0
Bippus fine sandy loam, 1 to 3 percent slopes	11	13	35	50	175	250	575	850	16	22	60	100	1. 75	2. 0	8	16	4. 0	6. 0
Mansker clay loam, 1 to 3 percent slopes	8	10	28	37	----	----	----	----	12	16	50	70	1. 1	1. 4	8	16	----	----
Mansker clay loam, 3 to 5 percent slopes	6	8	----	----	----	----	----	----	11	14	----	----	. 9	1. 1	----	----	----	----
Mansker and Mobeetie fine sandy loams, 1 to 3 percent slopes (Mobeetie soil only)	8	10	28	37	100	135	450	600	12	16	50	70	1. 1	1. 4	----	----	----	----
Miles fine sandy loam, 0 to 1 percent slopes	12	15	40	55	175	250	590	880	16	22	65	110	1. 75	2. 0	9	18	4. 0	6. 0
Miles fine sandy loam, 1 to 3 percent slopes	11	13	35	50	170	205	575	850	19	25	60	100	1. 75	2. 0	8	16	4. 0	6. 0
Miles fine sandy loam, 3 to 5 percent slopes	9	11	----	----	135	170	----	----	14	18	----	----	1. 2	1. 4	----	----	----	----
Miles fine sandy loam, 3 to 5 percent slopes, eroded	8	10	----	----	110	150	----	----	13	16	----	----	1. 1	1. 3	----	----	----	----
Miles loamy fine sand, 0 to 3 percent slopes	11	15	----	----	150	230	600	725	16	22	55	100	1. 25	1. 5	8	15	3. 0	4. 2
Olton clay loam, 1 to 3 percent slopes	11	13	35	50	150	175	400	500	15	21	65	100	1. 5	1. 75	9	16	3. 2	5. 0
Olton clay loam, 3 to 5 percent slopes	8	10	----	----	95	105	----	----	12	16	----	----	1. 0	1. 35	----	----	----	----
Olton loam, 0 to 1 percent slopes	13	15	35	50	180	225	450	550	19	23	70	120	1. 75	2. 0	11	22	4. 0	5. 5
Olton loam, 1 to 3 percent slopes	11	13	35	50	150	175	400	500	15	21	65	100	1. 25	1. 5	9	16	3. 2	5. 0
Olton loam, 3 to 5 percent slopes	8	10	----	----	95	105	----	----	12	16	----	----	1. 0	1. 35	----	----	----	----
Olton and Zita clay loams, 0 to 1 percent slopes (Zita soil only)	13	15	40	55	180	225	425	525	17	19	70	120	1. 75	2. 0	11	22	4. 0	6. 0
Olton and Zita clay loams, 1 to 3 percent slopes (Zita soil only)	12	14	35	50	150	175	400	500	14	17	65	100	1. 25	1. 5	9	16	3. 2	5. 0
Portales clay loam, 0 to 1 percent slopes	11	13	35	50	135	160	425	525	15	17	60	100	1. 5	1. 75	10	20	3. 5	5. 0
Portales clay loam, 1 to 3 percent slopes	10	12	32	45	135	160	400	500	13	16	50	85	1. 25	1. 5	8	16	3. 0	4. 5
Pullman clay loam, 0 to 1 percent slopes	12	14	35	55	150	180	400	500	16	18	70	115	1. 75	2. 0	11	22	3. 5	5. 5
Pullman clay loam, 1 to 2 percent slopes	11	13	30	45	140	165	300	400	14	15	65	100	1. 25	1. 5	9	16	3. 2	5. 0
Roscoe clay	11	13	35	50	----	----	----	----	15	17	65	110	1. 7	1. 9	11	22	3. 5	5. 5
Springer loamy fine sand, undulating	----	----	30	40	----	----	500	650	13	16	45	60	1. 2	1. 4	5	11	3. 0	4. 0
Spur clay loam	13	15	40	55	200	250	550	850	19	23	70	120	2. 0	2. 25	11	22	4. 0	6. 0
Spur and Guadalupe soils (Guadalupe soil only)	13	15	40	60	175	250	590	880	16	22	65	110	1. 75	2. 0	9	18	4. 0	6. 0

the county have been planted in windbreaks to protect farmsteads and feedlots and to beautify the area. These windbreaks reduce the velocity of the wind around the farmstead or feedlot and provide protection from blowing soil material and snow. They also make the feedlot warmer and protect livestock, give shelter to wildlife, and provide nesting areas for birds.

The soils of this county will support trees, but the trees must be watered occasionally. Introduced species that are planted as seedlings have proved to be the best trees for windbreaks. Chinese elm and eastern redcedar grow well on fine-textured soils, such as the Pullman and Olton clay loams. On these Pullman and Olton soils, they are used mostly for windbreaks around farmsteads and feedlots. Chinese elm, eastern redcedar, and Austrian pine grow on the more sandy soils, such as Miles loamy fine sand, Miles fine sandy loam, and Springer loamy fine sand; they are generally used for windbreaks on these Miles and Springer soils. Such shrubs as Russian-olive, wild plum, and desert-willow are used in windbreaks to provide food and cover for wildlife.

Technicians assisting members of the Soil Conservation District, or other qualified woodland specialists, can be consulted for help in planning a windbreak. They can help work out the spacing and selection of the trees or shrubs.

Use of the Soils for Range [4]

Approximately 60 percent, or about 392,249 acres, of the county is in range, and the raising of livestock is one of the most important enterprises. Most of this acreage is in the central and southeastern parts of the county. Areas of range, however, are scattered throughout the entire county. At the time this survey was made, 102 ranches were in the county, and the average size of those ranches was about 4,000 acres.

Most of the range is rolling, but a small part is hilly, broken, or stony. Some areas are deep and sandy, but the rolling areas range from deep to shallow. Under the present management these areas produce forage that is fair to good in amount and quality, but in many places the forage could be improved by better management.

Many of the present areas of range were originally covered by indiangrass, switchgrass, bluestem, sideoats grama, and similar grasses. Intensive grazing, coupled with periods of drought, has caused some deterioration, and most of the range is now in fair to good condition. Buffalograss, blue grama, and other short grasses have increased in areas that originally supported taller, more desirable species. Also, the number of woody plants has increased. Mesquite, pricklypear, cactus, and a small amount of yucca have invaded the range on the loamy soils, and sand sagebrush, yucca, wild plum, shin oak, skunkbush, and a small amount of mesquite have increased on the more sandy soils.

Nearly all of the ranchers and livestock farmers are in the cow-calf business. They produce calves to be marketed at weaning time or sometimes carry the calves over as stocker animals if feed is available. Some supplemental feeding of forage and grain crops, however, and a limited amount of finish feeding are also part of ranching operations in this county.

Range sites and condition classes

Range sites are distinctive kinds of rangeland that have a different potential for producing native plants. Within a given climate, the sites differ only in the kind or amount of vegetation they will produce. These differences are the result of varying soil characteristics, such as depth, texture, structure, position, and to a lesser extent, exposure and elevation.

The kind and the amount of vegetation a site will produce depend on the level of fertility, on the amount of air that enters the soil, and on the amount of water that is taken in and retained in the root zone. A range site made up of deep, fertile bottom-land soils that receive water by flooding, in addition to that received through normal rainfall, produces taller kinds and greater amounts of grass than an upland range site or a shallow site that receives less water.

Grass, like all other green plants, manufactures its food in the leaves and stems; therefore, the growth and reproduction of range plants are directly affected by the amount of grazing the plant receives. Under heavy grazing or overuse, the leaves and stems are reduced or destroyed. The result is a corresponding reduction in the amount of food received to maintain the plant and allow it to grow. If heavy grazing is continued over a period of years, many of the plants die.

Livestock tend to graze the most palatable and nutritious plants first; consequently, those plants are destroyed or damaged first. Plants that generally decrease under close grazing are called *decreasers*. The stand is thinned as the decreasers are eliminated. Then, less palatable plants, known as increasers and invaders, move in. *Increasers* tend to increase at first under heavy grazing but are the next plants to be reduced or eliminated. As the decreasers and increasers are eliminated, the condition of the range continues to decline and successively less desirable plants are dominant in the site. Finally, plants from other sites or from distant areas invade the plant community. These plants are known as *invaders*.

By this process, the plant composition of the range site, or the range condition, changes from excellent to poor. A range is in *excellent condition* if more than 75 percent of the present vegetation consists of the original, or climax, plants; in *good condition* if 50 to 75 percent consists of climax plants; in *fair condition* if 25 to 50 percent consists of climax plants; and in *poor condition* if less than 25 percent consists of climax plants.

Descriptions of range sites

Generally, there are several range sites in a pasture, but one site is normally preferred for grazing. This site can be used as a basis for managing and evaluating the grazing use of the entire pasture. If this key site is properly grazed, the entire pasture will improve. In Gray County there are 12 distinct range sites. A brief description of these sites follows.

LOAMY BOTTOMLAND RANGE SITE

In this range site are nearly level or gently sloping clay loams and fine sandy loams along streambeds in draws or valleys throughout the county. These soils are

[4] This section was prepared by DOUGLAS E. CUNNINGHAM, range conservationist, Soil Conservation Service.

20 inches deep or more and have moderate to moderately rapid permeability.

The soils of this site receive runoff from adjacent areas and support an excellent growth of plants. If they are not protected by a cover of plants, however, they are subject to scouring and flooding, and in some areas, to frequent flooding and deposition. The soils in this site are—

Spur clay loam.
Spur and Guadalupe soils.
Sweetwater soils.

The Sweetwater soils have a high water table, and some of the areas are saline. Where the water table is high, the carrying capacity is double that of other areas because the total volume of grass is greater than in other areas.

The vegetation on this site is tall and mid grasses. Prairie cordgrass, eastern gamagrass, tall dropseed, and sedges grow in areas that have a high water table. Indiangrass, switchgrass, sand bluestem, and other tall grasses that require less moisture grow on some of the other more favorable areas of this site. Alkali sacaton grows on the saline areas and makes up a large part of the plant cover in some of them. In saline areas or where the water table is high, decreasers make up a smaller part of the plant cover than in other areas. Decreasers make up 40 to 70 percent of the plant cover where this site is in excellent condition. The rest of the growth consists of increasers and a few trees.

Under good grazing management, the annual yield of air-dry herbage on this site, excluding that from woody species, ranges from 2,500 pounds per acre in dry years to 3,800 pounds in wet years.

SANDY BOTTOMLAND RANGE SITE

Only one mapping unit, Lincoln soils, is in this range site. These soils are nearly level or gently sloping and are along streambeds in draws and valleys in the central and eastern parts of the county. They have a surface layer of fine sandy loam to loamy fine sand and are 20 inches deep or more. Permeability is moderately rapid.

The growth of vegetation is generally excellent on this site because the soils receive runoff from adjacent areas. If the soils are not protected by a cover of plants, however, they are subject to scouring and blowing. Some areas are subject to frequent flooding and deposition, and some have a high water table or are saline.

The vegetation is mainly tall and mid grasses. Eastern gamagrass, prairie cordgrass, tall dropseed, and sedges grow on the areas that have a high water table. Indiangrass, switchgrass, sand bluestem, and other tall grasses that do not require a large amount of moisture grow in some of the other more favorable areas. Alkali sacaton grows in the saline areas; it makes up a large part of the vegetation in some of them. Where the soils are saline or the water table is high, decreasers make up a smaller part of the plant cover than in other areas. Decreasers make up 40 to 70 percent of the plant cover where the site is in excellent condition. The rest of the growth consists of increasers and a few trees.

Under good grazing management, the annual yield of air-dry herbage on this site, excluding that from woody species, ranges from 2,700 pounds per acre in dry years to 4,000 pounds per acre in wet years.

DEEP SAND RANGE SITE

Only Tivoli fine sand is in this range site. It occupies undulating to hummocky areas and stabilized dunes. This sandy soil is more than 60 inches deep and is rapidly permeable.

Where this soil is not protected by a cover of plants, it is highly susceptible to wind erosion. In the areas that have a good cover of plants, the intake of moisture is very high and only a small amount is lost through runoff. Under heavy grazing, the cover deteriorates rapidly and the turf cannot be maintained. The soil readily responds to good grazing management.

The characteristics that distinguish this site from the Sandyland site are more choppy and hummocky topography; taller and more robust woody plants, such as sand sagebrush, plumbush, shin oak, and skunkbush; big sandreed, which is absent on the Sandyland site; and the absence of blue grama, which is present on the Sandyland site. Also, sideoats grama on this site grows with poor to fair vigor, but it grows with fair to good vigor on the Sandyland site.

Where this site is in good to excellent condition, the vegetation is predominantly tall grasses, but there are also some mid and short grasses. In places decreasers make up as much as 55 percent of the plant cover; the rest of the growth consists of increasers. In small amounts sand sagebrush, shin oak, plum, skunkbush, and similar woody plants normally grow on this site.

Under good grazing management, the annual yield of air-dry herbage on this site, excluding that from woody species, ranges from 1,200 pounds per acre in dry years to 3,000 pounds per acre in wet years.

SANDYLAND RANGE SITE

In this range site are nearly level to moderately sloping, undulating and hummocky soils in the sandy areas of the county. These are loamy fine sands and fine sands that are more than 20 inches deep. They have moderate or moderately rapid permeability.

If this site is not protected by vegetation, the soils are highly susceptible to wind erosion. The intake of water is high on these soils, and only a small amount runs off. As a result, more water is available for the growth of plants than on other soils of the county. Deterioration caused by overgrazing is fairly rapid on this site, but the grasses respond well to good grazing management (fig. 17). The soils in this site are—

Likes loamy fine sand, 3 to 8 percent slopes.
Miles loamy fine sand, 0 to 3 percent slopes.
Miles loamy fine sand, 3 to 5 percent slopes.
Miles and Brownfield soils, 3 to 5 percent slopes, eroded.
Springer loamy fine sand, hummocky.
Springer loamy fine sand, undulating.
Tivoli complex.

The vegetation on this site is predominantly tall grasses, but there are some mid and short grasses. Decreasers, which make up 55 percent of the vegetation under climax range conditions, are little bluestem, sand bluestem, indiangrass, switchgrass, Canada wildrye, and needle-and-thread. Invaders are red lovegrass, queensdelight, western ragweed, tumblegrass, and woody plants.

Under good grazing management, the annual yield of air-dry herbage on this site, excluding that from woody species, ranges from 1,500 pounds per acre in dry years to 2,800 pounds per acre in wet years.

Figure 17.—An excellent stand of tall grasses on Likes loamy fine sand, 3 to 8 percent slopes. The range has been sprayed to control sand sagebrush, and grazing was deferred for 2 years after the range was sprayed.

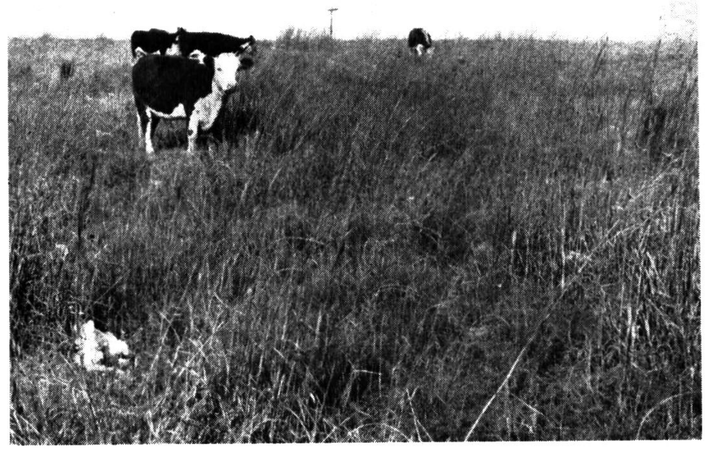

Figure 18.—A range in good condition on Mobeetie fine sandy loam.

SANDY LOAM RANGE SITE

In this range site are nearly level to moderately sloping soils in areas between the Sandyland and Hardland sites. These soils have a surface layer of fine sandy loam and are more than 20 inches deep.

If the soils of this site are not protected by a cover of plants, they are moderately to highly susceptible to wind erosion and moderately susceptible to water erosion. In areas that have a good cover of plants, the intake of water is moderately high and only a small amount of water runs off. As the condition of the range declines, there is a corresponding rapid deterioration in the structure of the surface layer. The rate of recovery is slow. The soils in this site are—

Bippus fine sandy loam, 1 to 3 percent slopes.
Miles fine sandy loam, 0 to 1 percent slopes.
Miles fine sandy loam, 1 to 3 percent slopes.
Miles fine sandy loam, 3 to 5 percent slopes.
Miles fine sandy loam, 3 to 5 percent slopes, eroded.

Decreasers make up about 60 percent of the plant cover under climax conditions. The rest of the growth consists mainly of increasers, but it includes woody plants in small amounts when the site is in excellent condition. Decreasers in the climax vegetation are sideoats grama, little bluestem, indiangrass, switchgrass, and needle-and-thread. Invaders are broom snakeweed, western ragweed, mesquite, and cactus.

Under good grazing management, the annual yield of air-dry herbage on this site, excluding that from woody species, ranges from 1,800 pounds per acre in dry years to 2,600 pounds per acre in wet years.

MIXEDLAND SLOPES RANGE SITE

The soils of this range site are nearly level to moderately steep and occupy transitional areas between the High Plains and the Rolling Plains. They are on rolling hills and ridges formed by the tributaries of streams on the Rolling Plains. These soils have a surface layer of fine sandy loam and are limy to the surface. Their loamy texture and content of lime make the soil-moisture relationship favorable (fig. 18). These soils are generally deep, but some shallow soils are included.

If the soils of this site are not protected by a cover of plants, they are highly susceptible to erosion by wind and water. The deep, moderately sloping soils are arable, but areas of such soils make up only a minor part of this site. The soils in this site are—

Mansker and Mobeetie fine sandy loams, 1 to 3 percent slopes.
Mobeetie fine sandy loam, 3 to 8 percent slopes.
Mobeetie-Mansker-Potter complex, 3 to 12 percent slopes (Mobeetie and Mansker soils only).

The vegetation is mainly mid grasses, but some tall and short grasses also grow on this site. Decreasers in the climax vegetation are sideoats grama, little bluestem, sand bluestem, and switchgrass. Blue grama is the chief increaser. Mesquite seldom invades this site, but yucca and sand sagebrush make up 25 to 40 percent of the vegetation in some places.

Under good management, the annual yield of air-dry herbage on this site, excluding that from woody species, ranges from 1,700 pounds per acre in dry years to 2,500 pounds per acre in wet years.

MIXEDLAND RANGE SITE

Only Woodward-Quinlan complex, 5 to 50 percent slopes, is in this range site. The soils of this complex are moderately sloping to steep and occur at the lower elevations in the county. They are reddish very fine sandy loams or loams and are more than 20 inches deep. These soils have moderately rapid permeability. If they are not protected by a cover of plants, they are moderately susceptible to erosion by wind and water.

The vegetation on this site is mid and short grasses on the deep soils and mid grasses on the shallow soils; mesquite and sand sagebrush grow in a few places. Decreasers that generally make up as much as 60 percent of the plant cover on this site are sideoats grama, little bluestem, and sand bluestem. The main increasers are blue grama, buffalograss, silver bluestem, and sand dropseed.

Under good grazing management, the annual yield of air-dry herbage on this site, excluding that from woody species, ranges from 1,600 pounds per acre in dry years to 2,500 pounds per acre in wet years.

DEEP HARDLAND RANGE SITE

The soils of this range site are nearly level to moderately sloping. They are in the western, central, and northern parts of the county. These soils are clays, clay

loams, and loams that are 20 inches deep or more and are slowly to moderately permeable. Where these soils are not protected by a cover of plants, they are slightly susceptible to erosion by wind and water. The soils in this site are—

Bippus clay loam, 1 to 3 percent slopes.
Olton clay loam, 1 to 3 percent slopes.
Olton clay loam, 3 to 5 percent slopes.
Olton loam, 0 to 1 percent slopes.
Olton loam, 1 to 3 percent slopes.
Olton loam, 3 to 5 percent slopes.
Olton and Zita clay loams, 0 to 1 percent slopes.
Olton and Zita clay loams, 1 to 3 percent slopes.
Portales clay loam, 0 to 1 percent slopes.
Portales clay loam, 1 to 3 percent slopes.
Pullman clay loam, 0 to 1 percent slopes.
Pullman clay loam, 1 to 2 percent slopes.
Roscoe clay.

The vegetation on this site is predominantly short grasses; mid grasses grow only in areas that receive extra water. Also, some woody plants are included in the climax vegetation. Decreasers that generally make up as much as 70 percent of the site are blue grama, vine mesquite, sideoats grama, and western wheatgrass. Increasers are buffalograss and silver bluestem. Mesquite readily invades if this site is overgrazed.

Under good grazing management, the annual yield of air-dry herbage on this site, excluding that from woody species, ranges from 1,400 pounds per acre in dry years to 2,200 pounds per acre in wet years. Production varies according to the kind and position of the soils and the amount of extra water received.

HARDLAND SLOPES RANGE SITE

The soils in this range site are nearly level to moderately steep. They are on long slopes in the transitional area between the High Plains and the Rolling Plains. A small acreage of this site is in nearly level areas of the High Plains and in sloping areas around playa lakes. These are deep loams and clay loams that are limy to the surface; the content of lime makes the soil-moisture relationship favorable.

If the soils of this site are not protected by a cover of plants, they are moderately susceptible to erosion by wind and water. The content of lime in the soils increases the hazard of erosion. This site deteriorates slowly, and a turf can be maintained, even under heavy grazing. The grasses respond readily to good grazing management. Small areas of gently sloping and moderately sloping soils in this site are arable. The soils in this site are—

Mansker clay loam, 1 to 3 percent slopes.
Mansker clay loam, 3 to 5 percent slopes.
Mansker clay loam, 5 to 8 percent slopes.
Mansker-Potter complex, 3 to 12 percent slopes (Mansker soil only).
Potter-Berthoud-Mansker complex, 5 to 20 percent slopes (Mansker and Berthoud soils only).

The vegetation on the site is predominantly mid and short grasses on the deep soils and mid grasses on the more shallow soils. Decreasers on this site are sideoats grama, vine mesquite, little bluestem, and Canada wildrye; increasers are blue grama, buffalograss, silver bluestem, three-awn, and sand dropseed.

Under good grazing management, the annual yield of air-dry herbage on this site, excluding that from woody species, ranges from 1,500 pounds per acre in dry years to 2,400 pounds per acre in wet years.

GRAVELLY RANGE SITE

Only Hilly gravelly land is in this range site. This land type is on hills near rivers and streams in areas underlain by red beds. The areas are at the lower elevations of the county. The soil material in these areas has a texture of sandy loam, contains gravel, and is more than 12 inches but less than 22 inches deep. It has moderately rapid permeability and is nonarable.

The vegetation on this site is predominantly mid grasses, but in small amount, short and tall grasses grow under climax conditions. Decreasers make up to 60 percent of the climax vegetation, and the rest of the growth consists of increasers. The main decreasers are sideoats grama, little bluestem, sand bluestem, and Canada wildrye. The main increasers are blue grama, hairy grama, silver bluestem, rough tridens, and sand dropseed. Where this site is in excellent condition, woody plants make up less than 5 percent of the stand.

Under good grazing management, the annual yield of air-dry herbage on this site, excluding that from woody species, ranges from 1,200 pounds per acre in dry years to 1,800 pounds per acre in wet years.

VERY SHALLOW RANGE SITE

The soils of this site are in rolling to hilly areas and occur with the soils of the Rough Broken site. They are in transitional areas between the deep soils and breaks. These soils are loams and fine sandy loams that are generally less than 12 inches but more than 4 inches deep. They have a high content of lime and a favorable soil-moisture relationship. This site is moderately accessible to livestock. The soils in this site are—

Mansker-Potter complex, 3 to 12 percent slopes (Potter soils only).
Mobeetie-Mansker-Potter complex, 3 to 12 percent slopes (Potter soils only).
Potter-Berthoud-Mansker complex, 5 to 20 percent slopes (Potter soils only).

The vegetation is predominantly mid grasses, but in small amount, tall and short grasses also grow on this site (fig. 19). The tall grasses grow in the more favor-

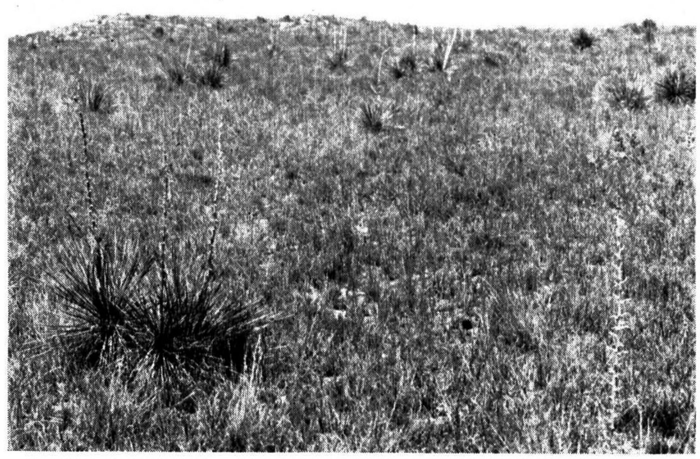

Figure 19.—**A thin stand of grass on the Very Shallow range site.**

able areas. Decreasers are little bluestem, sideoats grama, sand bluestem, indiangrass, switchgrass, and New Mexican feathergrass. In small amount, woody plants such as yucca and catclaw also grow on this site. Where the site is in excellent condition, decreasers make up 75 percent of the growth and the rest consists of increasers.

Under good grazing management, the annual yield of air-dry herbage on this site, excluding that from woody species, ranges from 600 pounds per acre in dry years to 1,000 pounds per acre in wet years.

ROUGH BROKEN RANGE SITE

Only Rough broken land is in this range site. This land type occupies steep escarpments and remnants of escarpments, ridges, and gullied areas. The areas are made up of sandstone, caliche, rocky material, and soil material in pockets, on mesas, and on foot slopes. A thin mantle of soil material is also interspersed with areas of exposed parent material. This site is generally very steep, and the soils are highly susceptible to water erosion. Some areas are not accessible to livestock.

The vegetation on this site is predominantly mid grasses, but in small amount, tall and short grasses also grow on this site. Decreasers in the climax vegetation are little bluestem, sand bluestem, sideoats grama, blue grama, black grama, indiangrass, switchgrass, and silver bluestem. Where this site is in excellent condition, decreasers make up as much as 70 percent of the vegetation in some places. In some places small amounts of woody plants, such as yucca, catclaw, and redberry juniper, also grow on the site.

Under good grazing management, the annual yield of air-dry herbage on this site, excluding that from woody species, ranges from 500 pounds per acre in dry years to 1,000 pounds per acre in wet years.

Use of the Soils for Wildlife

Antelope, buffalo, prairie chicken, and quail were once abundant in this county. Deer, turkey, and squirrel were plentiful along the wooded streams. The buffalo were exterminated by hunters about the time the county was settled. After the county was settled and livestock were introduced, overgrazing, fencing, and cultivation limited the numbers of antelope, deer, squirrel, turkey, and prairie chicken. Prairie dogs, once numerous, are now almost extinct. A large number of quails, doves, songbirds, small animals, and predators still inhabit the county. The playa lakes, streams, ponds, and grainfields attract many ducks and geese during migration. Habitats for fish are limited to artificial impoundments, such as Lake McClellan and some ponds on ranches.

Descriptions of wildlife sites

The soils of this county have been placed in four wildlife sites grouped by soil associations. The soil associations are shown on the general soil map at the back of this report and are described in the section "General Soil Map." Each site is unique in topography, productivity, kinds and amounts of vegetation, and principal species of wildlife that inhabit the site.

The first wildlife site consists of nearly level to gently undulating Pullman, Roscoe, Portales, Olton, Zita, and Randall soils of association 1. These soils are on the High Plains and in scattered playa lakes. Most of the association is cultivated. In areas that are not cultivated, the vegetation consists mainly of such short grasses as buffalograss, blue grama, western wheatgrass, and associated legumes and forbs. Water-tolerant grasses, sedges, and forbs grow in and around the playa lakes. The principal kinds of wildlife within this association are antelope, badger, coyote, and rabbit. Among the species of birds are doves, ducks, geese, quail, and songbirds.

The Mansker, Mobeetie, Miles, Bippus, Potter, Olton, Spur, and Guadalupe soils of associations 2 and 5 support the same kinds of wildlife, and therefore, they make up only one wildlife site. Most of the areas are rolling or steep and are cut by intermittent streams. The Spur and Guadalupe soils are on the narrow bottom lands of the streams. Much of the acreage in associations 2 and 5 is used for range consisting of grasses mixed with legumes and forbs. The grasses range from short to tall and are mainly buffalograss, blue grama, sideoats grama, little bluestem, sand bluestem, switchgrass, and indiangrass. A few scattered trees, such as Chinese elm, black locust, mesquite, and hackberry, grow on the soils of the uplands, redberry juniper on the areas of Rough broken land, and cottonwood and willow trees grow on the soils of the bottom lands. Sand sagebrush, wild plum, and skunkbush grow in a few places.

Antelope, deer, squirrel, bobcat, raccoon, rabbit, coyote, opossum, and badger inhabit this second wildlife site. The main kinds of birds are turkey, dove, quail, prairie chicken, ducks, geese, and songbirds. Largemouth bass, channel catfish, and bream are suitable fish for stocking farm ponds within these associations.

The third wildlife site is made up of rolling and duned areas of Likes, Springer, and Tivoli soils on the uplands and of Lincoln and Sweetwater soils on the bottom lands of association 3. Most of the areas are in range. Such tall and mid grasses as switchgrass, indiangrass, sand bluestem, little bluestem, big sandreed, sand lovegrass, sideoats grama, and eastern gamagrass grow on the wet bottom lands, along with associated legumes and forbs. Black locust, hackberry, shin oak, sand sagebush, skunkbush, and wild plum grow on the uplands. Trees on the bottom lands are cottonwood, willow, and saltcedar. Deer, squirrel, raccoon, rabbit, bobcat, and coyote are the principal animals on association 3. Among the birds on this association are turkeys, quail, doves, prairie chickens, ducks, geese, and songbirds.

The fourth wildlife site consists of the Miles, Springer, and Brownfield soils of association 4, on the undulating plain in the southeastern part of the county. Much of this association is used for cultivated crops. Such tall and mid grasses as switchgrass, indiangrass, sand bluestem, little bluestem, sand lovegrass, sideoats grama, and weeping lovegrass grow on the areas in range, along with associated grasses and forbs. Shin oak, sand sagebrush, wild plum, and skunkbush also grow in some areas. Badger, coyote, bobcat, opossum, rabbit, and raccoon inhabit this association. Quail, doves, prairie chickens, and songbirds are the principal birds that nest on this site.

Kinds of wildlife in the county

Dove, Quail, and Prairie Chicken.—These game birds require a year-round supply of food, such as seed from

weeds, grasses, legumes, small grains, and sorghum. They also eat a large number of insects in spring and summer. Low-growing shrubs are needed to provide shade, dusting and loafing areas, and escape cover from predators. Overgrown fence rows and field borders provide cover and food, as well as a protected trail for birds to move from place to place.

Several kinds of shrubs are adapted to the soils in this county. In areas where there is a shortage of shrubs for cover, shrubs may be planted in strategic locations (fig. 20). Some shrubs that are native to the area furnish no cover, because they have been damaged by the grazing or trampling of livestock. Fencing the areas will prevent damage from livestock. Tilling the soils stimulates the growth of annual weeds and grasses, which produce high-quality food for these birds. On soils such as the Miles, Pullman, Olton, Mansker, and Bippus, millet, sorghum almum, rye, or other similar crops make good plantings that provide food for wildlife. The waste grain in harvested fields is used extensively by doves. For best results, food plantings should be made close to good cover.

Ducks and Geese.—The intermittent lakes, impoundments, and flowing streams in the county are used by ducks and geese for feeding and roosting. Both ducks and geese feed on waste grain, and they roam into the surrounding cultivated fields in search of food. Geese feed extensively on winter weeds and young wheat in cultivated fields. Ducks eat the seeds of such plants as barnyard grass and smartweed that grow around the margins of ponds, along streambanks, and in playa lakes occupied by the Randall soils. Flooding from rainfall or from irrigation wells makes areas of the Randall soils excellent as feeding places for ducks in fall. Other soils in the county that take in water slowly may be similarly developed for ducks and geese.

Deer.—In this county deer inhabit only the larger wooded areas of bottom lands. The woody vegetation along streams is essential for a deer habitat. Deer prefer legumes, weeds, vines, some grasses and leaves, twigs, buds, and fruits of various shrubs as food. They also feed extensively on winter grain and on plantings of alfalfa. Growing these crops on the Spur and Guadalupe soils or on the Bippus, Miles, and other soils adjacent to wooded areas will make the best sites for deer habitats in this county.

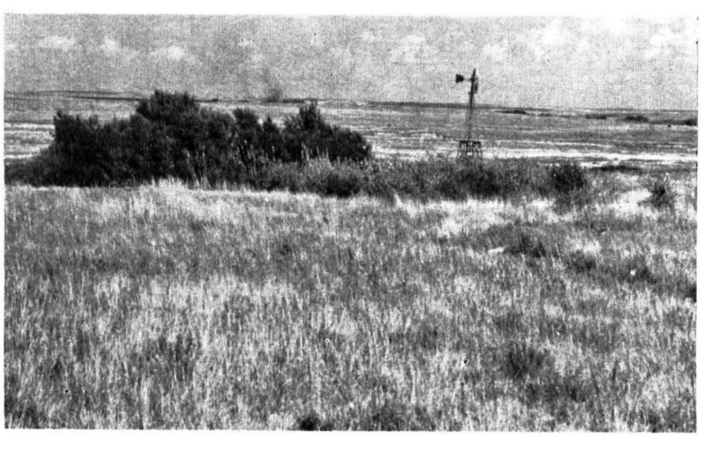

Figure 20.—**Wildlife sanctuary made by planting shrubs around a windmill and pond.**

Turkey.—These game birds live only on the bottom lands of associations 2 and 3. The woody vegetation along the streams adjacent to the Springer, Lincoln, Spur, and Guadalupe soils is essential for roosting areas, escape cover, and food. Turkeys require a year-round supply of food, such as seed from weeds, grasses, legumes, fruits of various shrubs, and succulent green vegetation. Also, they eat a large number of insects in spring and summer. These native foods are supplemented by waste grain sorghum or small grain.

In areas where there is a shortage of woody vegetation, trees and shrubs may be planted in strategic locations to provide cover and roosting places. On soils suitable for cultivation, such as the Bippus or Miles, millet, grain sorghum, or other similar crops make good food plantings for turkeys. These plantings should be close to suitable cover. The shortage of food in winter may be partly offset by supplemental feedings of grain.

Antelope.—Areas of associations 1 and 2 in this county are inhabited by antelope. These animals prefer areas of open grassland where the main plants are native forbs, grasses, shrubs, and cactuses that grow on the Pullman, Olton, Zita, Portales, Mansker, and Mobeetie soils. They also feed on winter small grains in fields near large areas of range. Improving the range, in addition to planting winter small grains near a supply of water, offers the best opportunity for developing habitats for antelope.

Fish.—In this county the areas for fish are limited to ponds on ranches and to lakes used primarily for recreation, constructed in the less permeable soils of the county. These areas are excellent for the production of fish if the pond water is properly managed. The pond should be at least a quarter of a surface acre in size. Fish adapted to waters in the county are largemouth bass, channel catfish, and bream. The objectives of management should be aimed at providing a large amount of food for the bream, which in turn furnish food for the bass, and eliminating aquatic plants, which harbor too many small bream and cause the pond to become overstocked. To reach these objectives, the pond must be properly constructed. Shallow areas that encourage the growth of aquatic plants should be eliminated. Fertilizer applied in a properly constructed pond stimulates the growth of microscopic plants and animals, which shade the bottom of the pond and prohibit the growth of plants. Also, production of fish in the fertilized ponds is sometimes more than double that in unfertilized ponds.

Each species of wildlife has a definite requirement for food, cover, and water. If any one or a combination of these requirements is lacking, the wildlife population diminishes or disappears. The soils in each wildlife site are capable of producing certain plants for food and cover for wildlife. Information on developing wildlife habitats and managing fish ponds can be obtained from technicians of the Soil Conservation Service who give assistance to the Gray County Soil Conservation District, from the Texas Agricultural Extension Service, and from the Texas Parks and Wildlife Department.

Engineering Uses of Soils [5]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, foundations for buildings, facilities for water storage, structures required for controlling erosion, drainage systems, and sewage disposal systems. The properties most important to the engineer are permeability to water, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, grain size, plasticity, and reaction. Depth to the water table, depth to bedrock, and the topography are also important.

The information in this report can be used to—

1. Make soil and land use studies that will aid in selecting and developing sites for industries, businesses, residences, and recreational areas.
2. Make preliminary estimates of the engineering properties of soils in the planning of agricultural drainage systems, farm ponds, irrigation systems, and other structures that help conserve soil and water.
3. Make preliminary evaluations of soils and ground conditions that will aid in selecting locations for highways, airports, pipelines, and cables and in planning detailed investigations at the selected locations.
4. Locate probable sources of sand, gravel, and other material suitable for construction.
5. Correlate performance of engineering structures with soil mapping units to develop information for overall planning that will be useful in designing and maintaining certain engineering practices and structures.
6. Determine the suitability of soil mapping units for cross-country movement of vehicles and construction equipment.
7. Supplement the information obtained from other published maps and reports and aerial photographs to make maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

It is not intended that this report will eliminate the need for on-site sampling and testing of sites for design and construction of specific engineering works and uses. It should be used only in planning more detailed field surveys to determine the condition of the soil, in place, at the site of the proposed engineering construction.

Although the detailed soil map and the tables serve as a guide for evaluating most soils, a detailed investigation at the site of the proposed construction is needed because as much as 15 percent of an area designated as a specific soil on the map may consist of areas of other soils too small to be shown on the published map. By comparing the soil description with the result of investigations at the site, the presence of an included soil can usually be determined.

Some of the terms used by the soil scientist may be unfamiliar to the engineer, and some words, for example, *soil*, *clay*, *silt*, *sand*, and *aggregate*, may have a special meaning in soil science. These terms and other special terms used in this report are defined in the Glossary at the back of the report.

Engineering classification systems

Agricultural scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture, color, and structure. This system is useful only as the initial step in making engineering classifications of soils. The engineering properties of a soil must be determined or estimated after the initial classification has been made. The systems used most by engineers for classifying soils are the systems used by the American Association of State Highway Officials (AASHO) and the Unified system. These systems are explained briefly in the following paragraphs. The explanations are taken largely from the PCA Soil Primer (*5*).

AASHO Classification System.—Most highway engineers classify soil material according to the system approved by the American Association of State Highway Officials (*1*). In this system soil material is classified in seven principal groups. These groups range from A-1, in which are gravelly soils of high bearing capacity, to A-7, which consists of clay soils having low strength when wet. Within each group, the relative engineering value of the soil material is indicated by a group index number. These numbers range from 0 for the best material to 20 for the poorest. The group index number is shown in parentheses in table 4, following the soil group symbol.

Unified Soil Classification System.—Some engineers prefer to use the Unified soil classification system. In this system soil material is divided into 15 classes (*12*). Eight classes (GW, GP, GM, GC, SW, SP, SM, and SC) are for coarse-grained material; six classes (ML, CL, OL, MH, CH, and OH) are for fine-grained material; and one class (Pt) is for highly organic material. Mechanical analyses are used to determine the GW, GP, SW, and SP classes; mechanical analyses and tests for the liquid limit and plasticity index are used to determine the GM, GC, SM, and SC classes and the fine-grained material. The soils of this county are classified according to the Unified classification system in tables 4 and 5.

Engineering test data and interpretations

Three tables are given in this section. The first (table 4) contains engineering test data for samples from five soil series. The second (table 5) gives estimated physical properties important to engineering. The third (table 6) indicates the suitability of the soils for various engineering uses.

Table 4 gives engineering test data, furnished by the Texas Highway Department, for samples of soils in the Likes, Mansker, Mobeetie, Portales, and Pullman series. The samples were tested for shrinkage, grain-size distribution, liquid limit, and plasticity index. According to the results of the tests, the soils were assigned ratings under the AASHO and Unified systems.

As moisture is removed, the volume of a soil decreases in direct proportion to the loss of moisture, until equilibrium, called the *shrinkage limit*, is reached. Beyond the shrinkage limit, more moisture may be removed, but

[5] By DAN C. HUCKABEE, agricultural engineer, Soil Conservation Service.

TABLE 4.—*Engineering*

Soil name and location	Parent material	Texas report No.	Depth	Horizon	Shrinkage Limit	Shrinkage Lineal	Shrinkage Ratio
			Inches				
Likes loamy fine sand:							
0.75 mile W. and 0.2 mile S. of the NE. corner of sec. 1, J. G. Eustis survey. (Modal profile)	Sandy material from the lower part of the Ogallala formation.	62–27–R	10–30	B2	17	3. 0	1. 75
		62–28–R	30–60	C	18	1. 8	1. 72
0.65 mile S. and 0.35 mile W. of the NE. corner of sec. 44, block A6, H. & G. N. RR. survey. (No AC horizon)	Sandy material from the lower part of the Ogallala formation.	62–26–R	8–72	C	17	2. 0	1. 78
0.55 mile W. and 100 feet N. of the SE. corner of sec. 12, block A6, H. & G. N. RR. survey. (Shallow profile)	Sandy material from the lower part of the Ogallala formation.	62–29–R	5–14	B2	19	2. 9	1. 66
		62–30–R	14–60	C	19	3. 1	1. 68
Mansker clay loam:							
0.5 mile W. and 250 feet S. of the NE. corner of sec. 2, block 1 of B. S. & F. RR. survey. (Nonmodal profile; low content of clay)	Alluvium.	62–38–R	14–26	B2	16	8. 2	1. 78
		62–39–R	40–72	C	13	7. 5	1. 89
Mobeetie fine sandy loam:							
0.65 mile W. and 0.5 mile S. of the NE. corner of sec. 56, block B2, H. & G. N. RR. survey. (Modal profile)	Alluvium.	62–33–R	10–30	B2	16	5. 5	1. 80
		62–34–R	46–72	C2	16	4. 1	1. 81
0.35 mile S. of the NE. corner of sec. 42, block A6, H. & G. N. RR. survey. (No Cca horizon)	Alluvium.	62–31–R	12–36	B2	17	3. 7	1. 76
		62–32–R	36–70	C	16	3. 7	1. 79
Portales clay loam:							
450 feet W. and 50 feet N. of the SE. corner of sec. 145, block B2, H. & G. N. RR. survey. (Modal profile)	Fine-textured eolian sediments.	62–50–R	10–34	B2 and Cca.	11	14. 9	1. 94
		62–51–R	34–60	C	12	14. 5	1. 99
300 feet N. and 40 feet E. of the SW. corner of sec. 142, block B2, H. & G. N. RR. survey. (Modal profile)	Fine-textured eolian sediments.	62–46–R	6–37	B2 and Cca.	15	12. 4	1. 93
		62–47–R	37–74	C1	11	13. 4	1. 97
0.5 mile S. and 100 feet E. of the NW. corner of sec. 111, block 3, I. & G. N. RR. survey. (Contains two Cca horizons)	Fine-textured eolian sediments.	62–48–R	9–22	B2	12	13. 8	1. 90
		62–49–R	22–60	C1ca and C2ca.	11	14. 2	1. 97
Pullman clay loam:							
0.45 mile W. and 50 feet S. of the NE. corner of sec. 114, block B2, H. & G. N. RR. survey. (Modal profile)	Fine-textured eolian sediments.	62–40–R	12–30	B22t	12	16. 2	1. 94
		62–41–R	45–78	B2tb	12	16. 7	1. 97
		62–42–R	78–90	Ccab	14	13. 7	1. 92
0.45 mile W. and 100 feet N. of the SE. corner of sec. 127, block B2, H. & G. N. RR. survey. (Deeper Bbca horizon than in modal profile)	Fine-textured eolian sediments.	62–35–R	12–26	B22t	13	16. 3	1. 96
		62–36–R	26–46	B23t	14	14. 5	1. 90
		62–37–R	46–96	Ccab	12	16. 0	1. 95
0.35 mile W. and 0.1 mile N. of the SE. corner of sec. 142, block B2, H. & G. N. RR. survey. (No Cca horizon)	Fine-textured eolian sediments.	62–43–R	8–24	B2t	12	16. 3	1. 95
		62–44–R	24–42	Bca	12	14. 5	1. 95
		62–45–R	42–84	B2tb	14	12. 2	1. 92

[1] Tests performed by the Texas Highway Department in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*1*).

[2] Mechanical analyses according to AASHO Designation T 88–57. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter.

test data [1]

Mechanical analysis [2]											Classification	
Percentage passing sieve—						Percentage smaller than—			Liquid limit	Plasticity index	AASHO	Unified [3]
2 in.	¾ in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.				
100	99	98	96	82	14	11	7	6	22	4	A-2-4(0)	SM-SC.
100	99	97	97	90	14	10	6	5	21	3	A-2-4(0)	SM.
100	97	93	92	76	15	10	5	4	21	4	A-2-4(0)	SM-SC.
100	99	95	95	90	18	13	6	5	24	4	A-2-4(0)	SM-SC.
100	99	97	97	95	29	18	6	5	24	5	A-2-4(0)	SM-SC.
-------	100	98	93	83	59	49	24	19	32	15	A-6(1)	CL.
-------	100	99	98	95	69	59	28	23	27	12	A-6(8)	CL.
-------	100	99	97	86	40	33	21	15	26	7	A-4(1)	SM-SC.
100	99	96	92	75	28	24	14	10	23	6	A-2-4(0)	SM-SC.
-------	--------	100	99	94	43	33	15	13	23	5	A-4(2)	SM-SC.
100	99	98	98	92	32	27	11	10	22	5	A-2-4(0)	SM-SC.
-------	--------	100	99	89	83	72	44	36	44	26	A-7-6(15)	CL.
-------	--------	--------	100	97	85	81	48	40	42	26	A-7-6(15)	CL.
-------	--------	100	97	88	79	67	39	33	41	24	A-7-6(14)	CL.
-------	--------	--------	100	99	84	73	44	38	38	23	A-6(13)	CL.
-------	100	99	98	89	79	70	42	32	42	25	A-7-6(14)	CL.
-------	--------	100	99	96	90	72	42	35	41	25	A-7-6(14)	CL.
-------	--------	--------	100	98	96	88	48	40	48	30	A-7-6(8)	CL.
-------	--------	--------	100	99	94	88	46	40	49	30	A-7-6(18)	CL.
-------	--------	--------	100	95	91	83	52	38	43	26	A-7-6(15)	CL.
-------	--------	--------	100	98	94	89	48	43	49	30	A-7-6(18)	CL.
-------	--------	--------	100	98	96	85	45	39	46	28	A-7-6(16)	CL.
-------	--------	--------	100	99	93	88	48	43	48	22	A-7-6(14)	ML-CL.
-------	--------	--------	100	98	93	89	46	40	48	30	A-7-6(18)	CL.
-------	--------	100	99	98	93	77	39	35	44	26	A-7-6(15)	CL.
-------	--------	--------	--------	--------	90	79	39	35	38	22	A-6(13)	CL.

In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[3] Based on the Unified soil classification system (*12*). SCS and Bureau of Public Roads have agreed that all soils having plasticity indexes within two points from the A-line are to be given a borderline classification. Examples of borderline classification obtained by this use are SM-SC and ML-CL.

TABLE 5.—*Estimated physical and chemical properties*

Soil type and map symbol	Depth from surface	Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
		USDA texture	Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
	Inches							*Inches per hour*	*Inches per inch of soil*	*pH value*	
Badland (Ba).	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1].
Bippus clay loam (BcB).	0 to 16	Clay loam	CL	A-6	95-100	95-100	40-70	0. 8 to 2. 5	0. 17	6. 5 to 7. 8	Moderate.
	16 to 60	Clay loam	CL	A-6	95-100	95-100	45-75	0. 8 to 2. 5	. 17	7. 8 to 8. 3	Moderate.
Bippus fine sandy loam (BfB).	0 to 16	Fine sandy loam.	SM-SC	A-4	95-100	90-100	30-40	1. 5 to 2. 5	. 13	6. 5 to 7. 8	Low.
	16 to 60	Clay loam to sandy clay loam.	CL	A-6	95-100	95-100	45-75	0. 8 to 2. 5	. 17	7. 8 to 8. 3	Moderate.
Hilly gravelly land (Hg).	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1].
Likes loamy fine sand (LfD).	0 to 30	Loamy fine sand.	SM	A-2	95-100	90-98	15-20	2. 5 to 5. 0	. 07	7. 5 to 8. 3	Low.
		Fine sand	SM	A-2	95-100	90-99	15-20	5. 0+	. 06	8. 0 to 8. 3	Low.
Lincoln soils (Ln).	0 to 12	Loamy fine sand.	SM	A-2	100	95-100	25-40	5. 0 to 10. 0	. 08	7. 5 to 8. 3	Low.
	12 to 60	Loamy sand	SM	A-2	100	90-100	15-25	5. 0 to 10. 0	. 07	8. 0 to 8. 3	Low.
Mansker clay loam (MaB, MaC, MaD, McD, MxD).	0 to 60	Clay loam	CL	A-6	100	95-100	60-80	0. 8 to 2. 5	. 16	8. 0 to 8. 3	Moderate.
Mansker and Mobeetie fine sandy loams, 1 to 3 percent slopes (MbB) (Mansker soil only).	0 to 7	Fine sandy loam.	SM or SC	A-4	95-100	90-95	30-40	2. 5 to 5. 0	. 13	7. 8 to 8. 3	Low.
	7 to 16	Loam	CL	A-6	95-100	95-100	50-60	0. 8 to 2. 0	. 16	8. 0 to 8. 3	Moderate.
	16 to 60	Clay loam	CL	A-6	95-100	95-100	45-90	0. 8 to 2. 5	. 16	8. 0 to 8. 3	Moderate.
Mansker-Potter complex (McD).[2]											
Miles loamy fine sand (MdB, MdC).	0 to 12	Loamy fine sand	SM	A-2	100	100	10-25	2. 5 to 5. 0	. 10	6. 0 to 6. 5	Low.
	12 to 40	Sandy clay loam.	SC or CL	A-6	100	100	40-55	0. 8 to 2. 5	. 15	6. 0 to 7. 0	Low to moderate.
	40 to 72	Loamy fine sand.	SM	A-4	100	100	10-25	2. 5 to 5. 0	. 10	6. 5 to 8. 0	Low.
Miles fine sandy loam (MfA, MfB, MfC, MfC2, MhC2).	0 to 8	Fine sandy loam.	SM or SC	A-4	100	100	20-35	2. 5 to 5. 0	. 13	6. 0 to 6. 8	Low.
	8 to 54	Sandy clay loam.	SC or CL	A-6	100	100	45-60	0. 8 to 2. 5	. 15	6. 5 to 7. 5	Low to moderate.
	54 to 72	Fine sandy loam.	SM or SC	A-4	100	100	20-35	2. 5 to 5. 0	. 13	6. 5 to 8. 0	Low.
Miles and Brownfield soils (MhC2) (Brownfield soil only)[2].	0 to 18	Fine sand	SP or SM	A-2	100	100	10-15	5. 0	. 06	5. 6 to 6. 0	Low.
	18 to 38	Sandy clay loam.	SC	A-4, A-6	100	100	25-40	0. 8 to 2. 5	. 15	6. 1 to 6. 5	Low to moderate
	38 to 60	Loamy fine sand.	SM	A-4	100	100	10-25	2. 5 to 5. 0	. 10	6. 5 to 8. 0	Low.

Mobeetie fine sandy loam (MbB, MoC, MxD).	0 to 60	Fine sandy loam.	SM or SC	A-4	95-100	90-95	30-45	2.5 to 5.0	.13	7.8 to 8.3	Low.
Mobeetie-Mansker-Potter complex (MxD). [2]											
Olton clay loam (OcB, OcC).	0 to 22	Clay loam	CL	A-6	100	95-100	80-95	0.2 to 1.0	.17	6.8 to 7.8	Moderate to high.
	22 to 60	Clay loam	CL	A-6	100	95-100	80-95	0.2 to 0.8	.17	7.8 to 8.3	Moderate to high.
Olton loam (OmA, OmB, OmC, OzA, OzB.).	0 to 6	Loam	CL	A-6	100	95-100	60-70	0.8 to 2.5	.15	6.5 to 7.0	Moderate.
	6 to 30	Clay loam	CL	A-6	100	95-100	75-85	0.2 to 0.8	.17	7.0 to 7.5	High.
	30 to 66	Sandy clay loam.	SC or CL	A-6	95-100	95-100	45-60	0.8 to 2.5	.15	8.0 to 8.3	Low to moderate.
Olton and Zita clay loams (OzA, OzB) (Zita soil only).	0 to 12	Silty clay loam.	CL	A-6	100	95-100	80-90	0.8 to 2.5	.16	6.5 to 7.5	High.
	12 to 60	Clay loam	CL	A-6	100	95-100	80-90	0.8 to 2.5	.12	8.0 to 8.3	Moderate.
Portales clay loam (PcA, PcB).	0 to 60	Clay loam	CL	A-6	100	70-100	80-90	0.8 to 2.5	.17	8.0 to 8.3	Moderate.
Potter-Berthoud-Mansker complex (PmE, McD, MxD) [2]:											
Potter soil.	0 to 8	Loam	ML or CL	A-4	90-100	85-95	50-70	0.8 to 2.5	.15	8.0 to 8.3	Low.
	8 to 60	Clay loam and caliche.	CL	A-6	85-95	85-95	50-80	0.8 to 2.5	.15	8.0 to 8.5	Low.
Berthoud soil.	0 to 60	Loam	CL	A-6	100	95-100	60-70	0.8 to 1.5	.16	7.8 to 8.3	Moderate.
Pullman clay loam (PuA, PuB).	0 to 6	Clay loam	CL	A-6	100	100	90-95	0.2 to 0.8	.18	6.5 to 7.5	Moderate to high.
	6 to 30	Clay	CL or CH	A-7-6	100	100	90-95	0.05 to 0.2	.17	7.0 to 7.8	High.
	30 to 48	Clay	CL or CH	A-7-6	100	100	90-95	0.05 to 0.2	.17	7.8 to 8.3	High.
	48 to 60	Clay loam	CL	A-6	100	100	90-95	0.2 to 0.8	.17	8.0 to 8.3	Moderate to high.
	60 to 84	Clay loam	CL	A-6	100	100	90-95	0.2 to 0.8	.16	8.0 to 8.3	Moderate.
Randall clay (Ra).	0 to 40	Clay	CH	A-7	100	100	75-95	0.00 to 0.05	.17	7.0 to 8.0	Very high.
	40 to 60	Clay	CH	A-7	100	100	75-95	0.00 to 0.05	.17	7.8 to 8.3	Very high.
Roscoe clay (Rc).	0 to 12	Clay	CH or CL	A-7	100	100	75-90	0.05 to 0.2	.17	7.0 to 8.0	High.
	12 to 60	Clay	CH	A-7	100	100	75-90	0.05 to 0.2	.18	7.8 to 8.3	Very high.
Rough broken land (Ro).	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1).
Springer loamy fine sand (Sa,Sb)	0 to 16	Loamy fine sand.	SM	A-2	100	100	15-20	2.5 to 5.0	.10	6.0 to 6.5	Low.
	16 to 60	Fine sandy loam.	SM	A-2	100	100	25-40	2.5 to 5.0	.13	6.0 to 7.0	Low.
Spur clay loam (Sc).	0 to 45	Clay loam	CL	A-6	100	95-100	60-95	0.8 to 2.5	.17	7.8 to 8.3	Moderate.
	45 to 60	Sandy clay loam.	SC or CL	A-6	95-100	95-100	40-55	0.8 to 2.5	.15	8.0 to 8.3	Low to moderate

See footnotes at end of table.

TABLE 5.—*Estimated physical and chemical properties*—Continued

Soil type and map symbol	Depth from surface	Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
		USDA texture	Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
	Inches							*Inches per hour*	*Inches per inch of soil*	*pH value*	
Spur and Guadalupe soils (Sg):											
Spur soil.	0 to 18	Fine sandy loam.	SM or SC	A-4	95-100	95-100	30-50	2. 5 to 5. 0	0. 13	7. 8 to 8. 3	Low.
	18 to 40	Sandy clay loam.	CL	A-6	95-100	95-100	50-75	0. 8 to 2. 5	. 15	8. 0 to 8. 3	Low to moderate.
	40 to 60	Fine sandy loam.	SM or SC	A-4	95-100	95-100	30-50	2. 5 to 5. 0	. 13	8. 0 to 8. 3	Low.
Guadalupe soil.	0 to 60	Fine sandy loam.	SM or SC	A-4	95-100	90-95	25-40	0. 8 to 2. 5	. 13	7. 8 to 8. 3	Low.
Sweetwater soils (Sw).	0 to 6	Silty clay loam.	CL	A-6	100	100	80-100	0. 2 to 0. 8	. 17	7. 5 to 8. 3	Low to moderate.
	6 to 20	Sandy clay loam.	SC or CL	A-4 or A-6	100	95-100	40-60	0. 8 to 2. 5	. 15	8. 0 to 8. 3	Low.
	20 to 60	Loamy fine sand.	SM	A-2	100	90-100	15-25	5. 0 to 10. 0	. 07	8. 0 to 8. 3	Low.
Tivoli fine sand (Tf).	0 to 60	Fine sand	SP or SM	A-3	100	95-100	10-20	5. 0 to 10. 0	. 06	6. 0 to 8. 3	Low.
Tivoli complex (Tm).	0 to 8	Loamy fine sand.	SM or SC	A-2	100	95-100	15-20	2. 5 to 5. 0	. 07	7. 5 to 8. 3	Low.
	8 to 60	Fine sand	SP or SM	A-3	95-100	95-100	15-20	5. 0+	. 06	8. 0 to 8. 3	Low.
Woodward-Quinlan complex (WcF).	0 to 60	Very fine sandy loam.	ML or CL	A-4	100	95-100	65-80	2. 5 to 5. 0	. 14	7. 8 to 8. 3	Low to moderate.

[1] Variable.

[2] For estimated properties of the Mansker soils, see Mansker clay loam; for estimated properties of the Potter soil, see the Potter-Berthoud-Mansker complex; and for properties of the Mobeetie soil, see Mobeetie fine sandy loam.

the volume of the soil does not change. In general, the lower the number indicated for the shrinkage limit, the higher the content of clay.

Lineal shrinkage is the decrease in one dimension, expressed as a percentage of the original dimension, of the soil mass when the moisture content is reduced from the stipulated percentage to the shrinkage limit.

The shrinkage ratio is the volume change, expressed as a percentage of the volume of soil material, divided by the amount of moisture lost through drying. This ratio is expressed numerically.

The effect of water on the consistence of the soil material is measured by determining the plastic limit, liquid limit, and plasticity index. The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. The *liquid limit* is the moisture content at which the material passes from a plastic to a liquid state. The *plasticity index* is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which soil material is in a plastic condition.

Table 5 gives estimates of the properties of the soils in this county that are significant to engineering. The AASHO and Unified designations for the Likes, Mansker, Mobeetie, Portales, and Pullman series are based on test data furnished by the Texas Highway Department from samples taken in Gray County. The classification of the other soils is based on the results of field tests, on experience and knowledge of the soils in the area, and on data for these soils in other soil survey reports.

The estimates given for permeability are for the soils in place. They were based on the structure and porosity of the soils and were compared with the results obtained by testing undisturbed cores of similar soil material.

The estimates of available water capacity, in inches per inch of soil depth, show the capacity of the soil to hold water in a form available to plants. It is the amount of moisture held in the soil between field capacity and the wilting point of most plants. When the soil is dry enough that the wilting point has been reached, this amount of water will wet the soil material to a depth of 1 inch without deeper percolation.

The column that shows reaction gives the degree of acidity or alkalinity of the soils. In this system of notations, pH 7.0 is neutral; lower values indicate acidity, and higher values indicate alkalinity.

The shrink-swell potential indicates the volume change of the soil material that can be expected with changes in content of moisture. This potential is based on tests of changes in volume or on observations of other physical characteristics of the soil. For example, Randall clay, which is very sticky when wet and develops large shrinkage cracks as it dries, has a high shrink-swell potential. In contrast, Tivoli fine sand, which is nonplastic and almost structureless, has a low shrink-swell potential.

Table 6 indicates the suitability of the soils for various engineering uses. In this table characteristics of the soils are named that affect suitability of the soils for the construction of highways and for agricultural engineering. These characteristics were estimated from data in table 4 and from experience with the performance of these soils in the field.

Table 6 rates the soils according to their suitability as a source of topsoil and road fill. To be suitable for topsoil, the soil material presumably must be fertile and suitable for use as a topdressing on roadbanks, lawns, and gardens.

The suitability of a soil as a source of material for road fill depends largely on the texture of the soil material and on the content of hydroscopic water. Such soils as Roscoe clay, Randall clay, and Pullman clay loam are difficult to compact and to dry to the desired moisture content. Therefore, these and similar soils are poor sources of material for road fill. Likewise, the Lincoln, Tivoli, and other sandy soils are difficult to place and are also difficult to compact because they do not contain enough particles of silt and clay. They are considered only fair as a source of material for road fill. The red beds are a good source of fines that can be mixed with sands to make a good material for road fill. The red beds underlie much of the same general area as that in which the sandy soils occur.

In this county the Miles and Springer loamy fine sands are among the most suitable soils for the location of highways or for use as the subgrade for highways. Poor soils for highways are Pullman clay loam and the Randall and Roscoe clays; they are plastic clays that have slow internal drainage and poor stability when wet. Likes loamy fine sand and other poorly graded loamy fine sands have a low percentage of material passing a No. 200 sieve. They are considered fair to good for the location of highways. They are highly erodible and generally lack stability, unless they are properly confined.

In this county seepage is moderate to high in many of the soils used as a reservoir area for ponds. In places the reservoir area needs special treatment to reduce excessive losses. Practically all of the soils can be used safely for an embankment around ponds if the soil material is placed carefully and is compacted.

Table 6 shows features that affect the suitability of the soils for irrigation. Irrigation was not extensive in Gray County until after the drought of the early fifties. Now, slightly more than 8,000 acres is irrigated, and there are approximately 55 irrigation wells in the county. The average yield of water from the wells is less than 700 gallons per minute. Underground pipelines are used in many places to prevent seepage and losses of water through evaporation.

The irrigation wells in the part of the county within the High Plains are drilled to a depth of 350 feet or more into the water-bearing sands and gravels of the Ogallala formation. These wells have a yield of 400 to 700 gallons per minute. Because of the slow or moderately slow permeability of the soils that are irrigated in this part of the county, the irrigation runs are relatively long and only a small stream of irrigation water is needed. Both the furrow and border types of irrigation are used.

In the part of the county that is within the Rolling Plains, irrigation wells are few because of the limited supply of underground water. The wells in use have a yield of only 200 to 300 gallons per minute. Sprinkler irrigation is the most practical in this area of moderately permeable soils, undulating slopes, and limited water supply.

TABLE 6.—*Interpretation of*

Soil type and map symbol [1]	Suitability as a source of—		Soil features affecting engineering practices	
	Topsoil	Road fill	Highway location	Foundations for low buildings
Badland (Ba)	Poor	Fair	Steep slopes; deep cuts and fills; active erosion.	Active erosion on the steep slopes.
Berthoud loam (PmE)	Fair	Fair	Slopes erode easily; requires deep cuts and fills; calcareous to the surface.	Good internal drainage; low shrink-swell potential; slopes erode easily.
Bippus clay loam (BcB)	Good	Fair	Well drained; moderate shrink-swell potential.	Good internal drainage; moderate shrink-swell potential.
Bippus fine sandy loam (BfB)	Good	Fair	Well drained; low to moderate shrink-swell potential.	Good stability; low to moderate shrink-swell potential.
Brownfield fine sand (MhC2)	Poor	Fair	Erodible by wind; requires moderate cuts and fills.	Highly stable subsoil; needs protection from erosion; good internal drainage.
Guadalupe fine sandy loam (Sg)	Fair	Fair	Subject to occasional flooding; requires fills.	Good stability; occasional flooding in some areas; low shrink-swell potential.
Hilly gravelly land (Hg)	Poor	Fair	Ledges of sandstone and gravel in some places; requires deep cuts and fills; the slopes erode easily.	Well drained; fair stability; the slopes erode easily.
Likes loamy fine sand (LfD)	Poor	Fair	Well drained; the slopes are unstable and erode easily; calcareous to the surface; erodible by wind.	Well drained; poor to fair stability; highly erodible.
Lincoln loamy fine sand (Ln)	Poor	Fair	Frequent flooding; high water table and running water in some areas; fills are necessary.	Subject to flooding
Mansker clay loam (MaB, MaC, MaD).	Fair	Fair	Slopes erode easily; calcareous throughout the profile; moderate to deep cuts and fills in the steeper areas.	Good internal drainage; moderate shrink-swell potential; slopes erode easily.
Mansker fine sandy loam (MbB)	Fair	Good	Slopes erode easily; calcareous throughout the profile.	Good internal drainage; fair stability; slopes erode easily; low to moderate shrink-swell potential.
Miles fine sandy loam (MfA, MfB, MfC, MfC2).	Good	Good	Steeper slopes erode easily; good internal drainage.	Good internal drainage; high stability; low shrink-swell potential.
Miles loamy fine sand (MdB, MdC).	Fair	Fair	Erodible by wind; the steeper areas require moderate cuts and fills.	Good internal drainage; high stability in the subsoil. The surface layer erodes easily.
Mobeetie fine sandy loam (MoC)	Fair	Fair	Slopes erode easily; requires deep cuts and fills; calcareous to the surface.	Good internal drainage; low shrink-swell potential; the slopes erode easily.
Olton clay loam (OcB, OcC)	Good	Fair	High shrink-swell potential; requires moderate cuts and fills; the slopes erode easily.	Good internal drainage; high shrink-swell potential.

See footnote at end of table.

engineering properties of soils

Soil features affecting engineering practices—Continued				
Farm ponds		Irrigation	Terraces and diversions	Waterways
Reservoir area	Embankment			
Moderate seepage; excessive silting.	Fair stability; erodible if used for a spillway; needs protection from erosion.	Too steep and erodible; contains little or no soil material.	Too steep; no location for outlets.	Too steep and is highly unstable and erodible.
Moderate seepage; will probably seal as the result of silting.	Good to fair stability; fair as a site for a spillway; fairly well graded.	Steep; moderate intake rate.	Highly erodible by both wind and water; steep.	Highly unstable and erodible; steep.
Moderate seepage; will probably seal as the result of silting.	Good to fair stability	Sloping; moderate intake rate.	Moderate permeability; silting in some channels; outlets are erodible.	Erodible; fertile.
Moderate seepage; will probably seal as the result of silting.	Good to fair stability; low to moderate shrink-swell potential.	Sloping; high intake rate.	Moderate permeability; some silting in channels; erodible in the outlets.	Highly erodible; fertile.
Large amount of seepage; excessive silting in places. Requires a blanket of compacted soil material.	Fair to good stability; some areas are poor as a site for a spillway.	Sloping; very high intake rate.	High susceptibility to erosion; the channels are subject to excessive silting.	Highly erodible.
Large amount of seepage; will generally seal as the result of silting.	Good stability; some areas are a poor foundation for fill.	Moderately high water-holding capacity; high intake rate; occasionally flooded.	Moderate permeability. Some areas occasionally flooded.	Erodible; fertile; subject to occasional flooding.
Large amount of seepage and highly stable; slopes erode easily.	Fair to poor stability; poor as a site for a spillway; contains gravel.	Steep	Contains strata of gravel and sand; steep, and the slopes erode easily.	Sandy and gravelly; erodible; difficult to construct; vegetation difficult to establish.
Large amount of seepage; blanket of compacted soil material required.	Poor stability; needs clayey material for a binder; poor as a site for a spillway and is a poor foundation for fill.	Steep and sandy; low capacity to hold water and plant nutrients.	Very high susceptibility to erosion; outlets are eroded easily.	Highly erodible; unstable sandy material; vegetation difficult to establish.
Excessive seepage; excessive silting in some places; probably will not hold water; subject to flooding.	Poor stability; poor foundation for fill; high water table in some places.	Sandy; low water-holding capacity; very high intake rate; subject to flooding.	Unstable; easily eroded by wind and water.	Subject to frequent flooding and receives accumulation of material from wind erosion and from flood deposition.
Large amount of seepage; will probably seal as the result of silting.	Fair stability; some areas are poor as a site for a spillway; moderate shrink-swell potential.	Sloping; low water-holding capacity; moderate intake rate.	Shallow over caliche; sloping	Erodible; hard to stabilize in the steeper areas.
Large amount of seepage; will probably seal as the result of silting.	Fair to good stability; some areas are poor as a site for a spillway.	Sloping; low water-holding capacity; high intake rate.	Shallow over caliche; sloping	Highly erodible; shallow over caliche.
Moderate seepage; will probably seal as the result of silting.	Good stability; well graded.	Undulating or sloping; high intake rate.	Moderately erodible; moderate permeability; undulating in some places.	Erodible; hard to stabilize in the steeper areas.
Moderate to large amount of seepage; excessive silting in some places; will probably seal as the result of silting.	Fair to good stability; well graded.	Undulating or sloping; very high intake rate; erodible by wind.	Sandy surface layer; high susceptibility to wind erosion; undulating topography; channels subject to excessive silting.	Highly erodible; excessive silting.
Moderate seepage; excessive silting in places; will probably seal as the result of silting.	Good stability; erodible if used as a site for a spillway; well graded.	Moderate intake rate; sloping, and some areas are steep.	Mainly too steep; highly erodible if used for outlets.	Highly erodible; low fertility.
Low seepage	Fair stability; high shrink-swell potential.	High water-holding capacity; low intake rate.	Moderately slow permeability	Slightly erodible; the steeper areas are hard to stabilize.

TABLE 6.—*Interpretation of engineering*

Soil type and map symbol [1]	Suitability as a source of—		Soil features affecting engineering practices	
	Topsoil	Road fill	Highway location	Foundations for low buildings
Olton loam (OmA, OmB, OmC)	Good	Fair	High shrink-swell potential; the steeper slopes erode easily and need moderate cuts and fills.	Good internal drainage; moderate to high shrink-swell potential.
Potter gravelly loam (PmE)	Poor	Fair	Requires deep cuts and fills; contains stones and boulders in some places.	Underlain by hard caliche in some places; fair stability.
Portales clay loam (PcA, PcB)	Good	Fair	Moderate shrink-swell potential; calcareous throughout the profile.	Moderate shrink-swell potential; poor stability; good internal drainage.
Pullman clay loam (PuA, PuB)	Good	Poor	High shrink-swell potential; slow surface runoff.	High shrink-swell potential; poor stability.
Quinlan loam (WcF)	Poor	Fair	Low shrink-swell potential; requires deep cuts and fills; shallow over red-bed material.	Low shrink-swell potential; good stability; shallow over red-bed material.
Randall clay (Ra)	Poor	Poor	Flooded for months at a time; high shrink-swell potential; requires fills.	Periodic flooding; high shrink-swell potential.
Roscoe clay (Rc)	Fair	Poor	High shrink-swell potential; slow surface runoff.	High shrink-swell potential; poor stability.
Rough broken land (Ro)	Poor	Fair	Requires deep cuts and fills; the slopes erode easily; contains stones and boulders in some places.	Active erosion on the steep slopes
Springer loamy fine sand (Sa, Sb)	Good	Good	Erodible by wind; requires moderate cuts and fills in the steeper areas; stable for foundations.	Low shrink-swell potential in the subsoil; good stability; the surface layer erodes easily.
Spur clay loam (Sc)	Good	Fair	Occasional flooding; requires fills	Fair stability; occasional flooding in some areas; moderate shrink-swell potential.
Spur fine sandy loam (Sg)	Good	Fair	Subject to occasional flooding; some areas have a water table at a depth of about 3 feet; requires fills.	Fair stability; occasional flooding in some areas; low to moderate shrink-swell potential.
Sweetwater soils (Sw)	Fair	Fair	High water table; subject to occasional flooding; requires fills.	Occasional flooding; high water table.
Tivoli fine sand (Tf)	Poor	Fair	Highly unstable slopes; requires deep cuts and fills; hazard of wind erosion.	Poor to fair stability; well drained; highly erodible.
Woodward very fine sandy loam (WcF).	Fair	Fair	Low shrink-swell potential; the slopes erode easily; requires deep cuts and fills.	Low shrink-swell potential; good stability; well drained.
Zita clay loam (OzA, OzB)	Good	Fair	Moderate shrink-swell potential; calcareous below a depth of 15 inches; slow surface runoff.	Moderate shrink-swell potential; poor stability; good internal drainage.

[1] Soil complexes are not listed separately. For information about the suitability and characteristics of the soils in complexes, refer to the individual soils.

properties of soils—Continued

Soil features affecting engineering practices—Continued				
Farm ponds		Irrigation	Terraces and diversions	Waterways
Reservoir area	Embankment			
Low seepage	Fair stability; moderate to high shrink-swell potential.	High water-holding capacity; moderate intake rate.	Moderately slow permeability	Slightly erodible.
Stony in places; moderate seepage.	Stony in places; high shrink-swell potential; fair stability.	Steep and shallow	Shallow over bedrock or caliche.	Stony and shallow.
Moderate seepage; will generally seal as the result of silting.	Moderate shrink-swell potential; fair stability.	Moderate water-holding capacity; moderate intake rate.	Moderate permeability	Calcareous and erodible.
Low seepage	Fair to poor stability	High water-holding capacity; low intake rate.	Slow permeability; slightly difficult to farm with multi-row equipment.	Slightly erodible.
Moderate seepage	Good stability	Steep	Steep; shallow over red-bed material.	Erodible and steep; shallow over red-bed material.
Practically impervious	High shrink-swell potential; poor stability; generally suitable only for dug ponds.	High water-holding capacity; very low intake rate; periodic flooding.	Periodic flooding	Periodic flooding.
Low seepage	Fair to poor stability; high shrink-swell potential.	High water-holding capacity; low intake rate.	Diversions may be needed to protect from runoff from adjacent slopes; very slow permeability.	Slightly erodible.
Moderate seepage; excessive silting in some places.	Fair stability; most areas are poor as a site for a spillway.	Steep	Too steep for terraces	Highly erodible; steep stony slopes.
Large amount of seepage; excessive silting in places; a blanket of compact soil material required.	Fair stability; needs protection from erosion; some areas are poor as a site for a spillway.	Low water-holding capacity; very high intake rate; some areas sloping.	Highly erodible, sandy surface layer difficult to maintain; channels are subject to excessive silting.	Highly erodible; excessive silting with age.
Moderate seepage; will generally seal as the result of silting.	Fair to good stability; poor foundation for fill in some places.	High water-holding capacity; moderate intake rate; occasional flooding.	Moderate permeability; occasional flooding in some areas.	Fertile; subject to occasional flooding.
A large amount of seepage; will generally seal as the result of silting.	Fair to good stability; poor foundation for fill in some places.	Moderately high water-holding capacity; high intake rate; occasional flooding.	Moderate permeability; occasional flooding in some areas.	Erodible; fertile; subject to occasional flooding.
Excessive seepage; retains water at the level of the water table.	Fair to poor stability; poor foundation for fill; suitable for dug ponds; high water table.	High water table	High water table; occasional flooding; highly erodible sands.	High water table; occasional flooding or ponding in some areas.
Excessive seepage; probably will not hold water.	Poor stability; needs protection from erosion; poor as a site for a spillway.	Very sandy; very low capacity to hold water and plant nutrients.	Highly erodible sands that have poor stability.	Highly erodible, unstable sands.
Moderate seepage	Good stability; some areas poor as a site for a spillway.	Steep slopes	Moderately rapid permeability; steep slopes; highly erodible outlets.	Erodible; steep slopes.
Moderate seepage; will generally seal as the result of silting.	Moderate shrink-swell potential; fair stability.	High water-holding capacity; moderate intake rate.	Moderate permeability	Slightly erodible.

Field terraces and diversion terraces constructed from coarse-textured soil material are difficult to maintain. Where coarse-textured material is used for constructing them, both the ridges and channels are highly susceptible to erosion by wind and water. Also, as shown in table 6, some soils are too steep or too shallow over caliche or bedrock to be suitable for terraces.

Some of the soils of the county are not well suited to waterways, because they are highly erodible or are hard to stabilize. Windblown material that accumulates in waterways in areas of highly erodible soils make maintenance difficult. If the windblown material covers the permanent vegetation in the waterways, the water-carrying capacity is reduced.

In table 6 the soils are not rated according to their suitability as a source of sand and gravel, for suitability for septic tank filter fields, or for susceptibility to frost action and suitability for winter grading. These factors are discussed briefly in the following paragraphs.

In Gray County stratified sand and gravel lie beneath areas mapped as Hilly gravelly land, and in most places they overlie the material in the red beds. In most of these areas, the amount of gravel is limited, but a fair amount of sand is available. The material underlying the Potter soils, and areas where limestone crops out, are possible sources of hard caliche. Soft caliche, not considered a good material for construction, underlies the Mansker soils and areas mapped as Rough broken land. Thin layers of soft caliche also occur at a depth of 3 to 8 feet under most of the other soils of the High Plains.

Some kind of system for disposing of sewage is needed for homes in rural areas and in the small communities that lack a sewage system. The sandy, moderately sandy, and calcareous soils that are moderately to rapidly permeable are well suited to filter fields for sewage disposal. Filter fields do not function properly, however, in soils such as the Pullman, Olton, and Roscoe that have slow or moderately slow permeability in the subsoil. At present, many residents of rural areas depend for their sewage disposal upon wells about 3 feet in diameter and 40 to 50 feet deep. As a result, much of the waste from sewage is placed in the calcareous loamy substratum underlying most of Gray County. In the Rolling Plains area, the calcareous substratum is nearer the surface.

In this county, grading can usually be done in winter. Damage as the result of frost action is not considered serious, because the soils generally have a low content of moisture during the winter. Also, the temperatures are generally below freezing for only short periods.

Formation, Classification, and Morphology of Soils

This section consists of three main parts. Discussed in the first part, in terms of their effects on the formation of soils in Gray County, are the factors of soil formation and the processes of horizon differentiation. In the second part, the two systems currently used in classifying soils are described and the soils are placed in these systems. In the third part, the morphology of the soils is discussed and a detailed description of each soil series is given.

Formation of Soils

The five major factors of soil formation are climate, living organisms (especially vegetation), parent material, topography, and time. Soil is produced when these five factors interact. The kind of soil that forms in one area differs from the kind of soil in another area if there has been a difference between the two areas in climate, vegetation, or any other factor.

CLIMATE

The climate of Gray County is warm, semiarid, and presumably similar to the climate that existed when the soils were formed. Because rainfall is low, the development of the soils has been retarded. Major differences in the soils are not the result of the macroclimate, for the climate is uniform throughout the county. Local differences in the soils can be partly attributed to climate in areas where its effect has been modified by runoff and relief.

LIVING ORGANISMS

Plants, animals, insects, bacteria, and fungi are important in the formation of soils, for their activity has caused changes as the soils have developed. Among these changes are gains in organic matter and nitrogen, gains or losses in plant nutrients, and changes in the structure and porosity of the soils.

In this county vegetation, especially grasses, has had a dominant effect on the formation of soils. Because the vegetation was grassy, soils were produced that are high or medium in content of organic matter and relatively dark colored in the surface layer. Exceptions are the Tivoli soils and similar soils that are relatively low in content of organic matter because they formed in sandy parent material.

PARENT MATERIAL

Parent material is the unconsolidated mass from which soil forms. It determines the chemical and mineralogical composition of the soil. The parent material of the soils of Gray County is of mixed origin and consists largely of calcareous or alkaline, unconsolidated loamy and sandy earths. The Olton, Pullman, Portales, and similar soils that formed in loamy parent material generally have a greater degree of development than the Likes, Tivoli, Springer, and similar soils that formed in sandy parent material. The Olton soils, for example, have accumulated clay in the subsoil, but the sandy Tivoli soils have the same texture throughout.

The parent material of most of the soils in the county contains a small to a large amount of lime. The finer sized particles in the parent material also contain a larger amount of weatherable minerals than the coarse-textured particles, and these minerals are made available to plants during the process of soil formation. The size of the particles also influences the rate at which water enters and percolates through the soil and the amount of moisture held by the soil material. Water enters and percolates rapidly through sand, but little of it is held by the soil material. In contrast, water enters and percolates slowly through clays, which hold much of it. More detailed information about the origin of the parent materials in this county can be found in the section "Geology."

RELIEF

Relief affects the formation of soils through its local influence on drainage and runoff, rate of erosion, plant cover, and exposure to sun and wind. Drainage and runoff largely determine the amount of moisture in the soil, and moisture, in turn, affects the degree of development in the soil profile. Moisture also has much to do in determining the kinds and amounts of plant and animal life on and in the soil. Mansker clay loam and other soils on the steeper slopes absorb less moisture and normally have less well-developed profiles than Miles fine sandy loam and other soils in nearly level and gently sloping areas. Soils, such as the Bippus, that occur on foot slopes or in concave areas receive additional water and sediments from other soils and have developed thick, dark-colored A horizons.

TIME

Time, generally a long time, is required for the formation of soils that have distinct horizons. Differences in the length of time that the parent material has been in place are commonly reflected in the degree of development of the soil profile.

The soils in Gray County range from young to old. The young soils have very little profile development, and the older soils have well-developed horizons. For example, the Mobeetie soils are young and have a weakly developed profile. Except for the darkening of their surface layer, the Mobeetie soils have retained most of the characteristics of their calcareous fine sandy loam parent material. The Olton soils are older than the Mobeetie soils and formed in a more clayey parent material, but the blocky clay loam subsoil of the Mobeetie soils resembles the parent material very little.

Processes of Horizon Differentiation

Several processes were involved in the formation of horizons in the soils of this county. These processes are (1) the accumulation of organic matter, (2) the leaching of calcium carbonates and bases, (3) the liberation, reduction, and transfer of iron, and (4) the formation and translocation of silicate clay minerals. In most soils, more than one of these processes have been active in the development of horizons.

The accumulation of organic matter in the upper part of the profile has been important in the formation of an A1 horizon. For example, the Sweetwater soils have a high content of organic matter, but the Tivoli soils contain only a small amount.

Carbonates and bases have been leached from nearly all of the soils of this county. This leaching has contributed to the development of horizons. Soil scientists generally agree that the removal of carbonates from the upper horizons of a soil generally precedes the translocation of silicate clay minerals. Carbonates have been leached from most of the soils in the county to depths of 16 to 60 inches. The Bippus soils, for example, have been leached to a depth of 16 inches and have only a weak textural horizon below that depth. On the other hand, the Springer soils have been leached to a depth of 60 inches and have a thick textural horizon that begins at a depth of about 16 inches. Also, leaching contributed to the development of weak textural horizons in the Mobeetie soils and to the strong textural horizons in the Pullman soils.

The reduction and transfer of iron, a process called gleying, is evident in the poorly drained Sweetwater soils of this county. The gray color in the subsoil horizons indicates the reduction and loss of iron. Some horizons contain mottles, which indicate segregation of iron.

In the translocation of clay minerals, which probably followed the leaching of free carbonates and soluble salts, the eluviated A horizons have a granular structure and are lower in content of clay than the B2t horizons. The accumulated clay in the B2t horizon is in pores and forms films on the surfaces of peds. In the soils of this county, leaching of bases and the translocation of silicate clays are among the more important processes in horizon differentiation. The Olton soils are an example of soils that have translocated silicate clays accumulated in the B2t horizon in the form of clay films.

Classification and Morphology of Soils

Soils are placed in narrow classes so that knowledge about their behavior within farms, ranches, or counties can be organized and applied more readily. They are placed in broad classes so that they can be studied and compared in large areas, such as continents.

Two systems of classifying soils are now in general use in the United States. One of these is the 1938 system (*2*, *9*), with later revisions. The other, a new system (*7*, *11*), was placed in general use by the Soil Conservation Service in 1965. In this report the newer system is used almost exclusively, but the placement of soils in the older system is also given (see table 7).

Under the new system, all soils are placed in six categories. They are, beginning with the most inclusive, the order, the suborder, the great group, the subgroup, the family, and the series. In this system the criteria used as bases for classification are observable or measurable properties. The properties are chosen, however, so that soils of similar mode of origin are grouped together.

The 1938 system, with later revisions, also consists of six categories. In the highest of these, the soils of the whole country have been placed in three classes of order. The next two categories, the suborder and the family, have never been fully developed. As a consequence, they have not been used much in the past. More attention has been centered on the lower categories, the great soil group, the soil series, and the soil type. A further subdivision of the soil type, called a soil phase, is defined along with soil type and soil series, in the section "How This Survey Was Made" in the front of this report.

In table 7, each soil series of Gray County is placed in its family, subgroup, and order of the new classification system, and in its great soil group of the older system. Following the table, the morphology of the soils of each series is discussed and a description of a soil profile typical of the series is given. The soil series are discussed in alphabetic order.

BERTHOUD SERIES

In the Berthoud series are deep, loamy, dark grayish-brown to light brownish-gray soils of the uplands. These soils are well drained and moderately permeable. They developed in calcareous, medium-textured alluvium

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TABLE 7.—*Soil series classified according to the present system* [1] *of classification and the 1938 system with its later revisions*

Series	New classification			Old classification
	Family	Subgroup	Order	Great soil group
Berthoud	Fine loamy, mixed, thermic	Mollic Camborthids	Aridisols	Regosol.
Bippus	Fine loamy, mixed, thermic	Cumulic Haplustolls	Mollisols	Chestnut.
Brownfield	Fine loamy, siliceous, thermic	Arenic Haplustalfs	Alfisols	Reddish Brown.
Guadalupe	Coarse loamy, siliceous, nonacid thermic	Cumulic Haplorthents	Entisols	Alluvial.
Likes	Siliceous, nonacid, thermic	Typic Normipsamments	Entisols	Regosol.
Lincoln	Siliceous, nonacid, thermic	Typic Normipsamments	Entisols	Alluvial.
Mansker	Fine loamy, mixed, thermic	Typic Calciustolls	Mollisols	Calcisol.
Miles	Fine loamy, mixed, thermic	Mollic Haplustalfs	Alfisols	Reddish Chestnut.
Mobeetie	Coarse loamy, mixed, thermic	Mollic Camborthids	Aridisols	Regosol.
Olton	Fine, mixed, thermic	Typic Argiustolls	Mollisols	Reddish Chestnut.
Portales	Fine loamy, mixed, thermic	Haplic Calciustolls	Mollisols	Calcisol.
Potter	Loamy, carbonatic	Typic Haplorthents	Entisols	Lithosol.
Pullman	Fine, mixed, thermic	Typic Argiustolls	Mollisols	Chestnut.
Quinlan	Fine silty, mixed, thermic, thin	Typic Ustochrepts	Inceptisols	Regosol.
Randall	Thermic	Typic Mazaquerts	Vertisols	Grumusol.
Roscoe	Thermic	Typic Grumaquerts	Vertisols	Grumusol.
Springer	Coarse loamy, siliceous, thermic	Typic Haplustalfs	Alfisols	Reddish Brown.
Spur	Fine loamy, mixed, thermic	Cumulic Haplustolls	Mollisols	Alluvial.
Sweetwater	Sandy, siliceous, thermic	Typic Haplaquolls	Mollisols	Humic Gley.
Tivoli	Siliceous, nonacid, thermic	Typic Normipsamments	Entisols	Regosol.
Woodward	Fine silty, mixed, thermic	Typic Haplustolls	Mollisols	Regosol.
Zita	Fine loamy, mixed, thermic	Typic Haplustolls	Mollisols	Chestnut.

[1] Placement of some soil series in the present system of classification, particularly in families, may change as more precise information becomes available.

washed down from the slopes above. The Berthoud soils occur along the dissected margin of the High Plains. Their slopes are between 5 and 12 percent.

The Berthoud soils are calcareous and have a thinner, lighter colored surface layer than the Bippus soils. They are slightly more clayey than the Mobeetie soils and are also more clayey than the Likes soils. The Berthoud soils are more sandy and have less calcium carbonate in their subsoil than the Mansker soils.

The following describes a typical profile of Berthoud loam 0.2 of a mile east and 500 feet south of the northwest corner of section 54, Block A6, H. & G. N. RR. survey:

A1—0 to 8 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; moderate, fine and very fine, granular structure; hard when dry, friable when moist; few worm casts; few fine pores; few fine and very fine fragments of hard caliche; calcareous and moderately alkaline; clear boundary.

B2—8 to 20 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak, coarse, prismatic and weak, fine, subangular blocky structure; hard when dry, friable when moist; few worm casts; few fine pores; few fine and very fine fragments of hard caliche; few threads and films of calcium carbonate on the surfaces of the peds; calcareous and moderately alkaline; gradual boundary.

Cca—20 to 35 inches, pale-brown (10YR 6/3) loam, yellowish brown (10YR 5/4) when moist; weak, coarse, prismatic and weak, fine, subangular blocky structure; slightly hard when dry, friable when moist; few worm casts; few fine pores; a few threads and films, a few very fine, soft masses and concretions, and a few hard fragments of calcium carbonate that make up about 2 to 4 percent, by volume, of the soil mass; calcareous and moderately alkaline; diffuse boundary.

C—35 to 50 inches, very pale brown (10YR 7/4) loam, yellowish brown (10YR 5/4) when moist; weak, subangular blocky structure; slightly hard when dry, friable when moist; a few medium to very fine concretions of calcium carbonate and a few hard fragments of caliche; calcareous and moderately alkaline.

The A1 horizon ranges from 5 to 12 inches in thickness and from dark grayish brown to light brownish gray in color. The texture of all the horizons is mostly loam, but it is fine sandy loam in a few places. The Cca horizon is lacking in a few places. The content of visible calcium carbonate in the Cca horizon is generally about 3 percent, by volume, but it ranges from 1 to 5 percent.

BIPPUS SERIES

The Bippus series is made up of deep, brown to very dark grayish-brown clay loams and fine sandy loams that are on uplands. These soils are well drained and moderately permeable. They developed in calcareous, loamy alluvium that washed down from the slopes above. These soils are on foot slopes along the dissected margin of the High Plains. They have slopes of 1 to 3 percent.

The Bippus soils have a thicker, darker colored surface layer and a more clayey subsoil than the Mobeetie and Berthoud soils. They are less reddish than the Miles and Olton soils, and they lack a distinct textural B horizon.

The following describes a typical profile of Bippus clay loam 0.6 of a mile south and 50 feet west of the northeast corner of section 52, Block A6, H. & G. N. RR. survey:

A11—0 to 8 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) when moist; weak, coarse, prismatic and moderate, fine and very fine, subangular blocky structure; very hard when dry, friable when moist; common fine and very fine pores; common worm casts; noncalcareous and neutral; gradual boundary.

A12—8 to 16 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) when moist; weak, coarse, prismatic and moderate, medium and fine, subangular blocky structure; very hard when dry, friable when moist; common fine and very fine pores; common worm casts; noncalcareous and mildly alkaline; gradual boundary.

B2—16 to 32 inches, grayish-brown (10YR 5/2) clay loam, brown (10YR 4/3) when moist; weak, coarse, prismatic and weak, fine, subangular blocky structure; very hard when dry, friable when moist; many medium to very fine pores; common worm casts; few fine and very fine concretions of calcium carbonate and threads and films of calcium carbonate on the surfaces of the peds; calcareous and moderately alkaline; gradual boundary.

C1ca—32 to 52 inches, very pale brown (10YR 7/3) clay loam, light yellowish brown (10YR 6/4) when moist; very hard when dry, friable when moist; a few soft masses and concretions of calcium carbonate and a few threads and films of calcium carbonate; calcareous; gradual boundary.

C2—52 to 62 inches +, very pale brown (10YR 7/3) clay loam, light yellowish brown (10YR 6/4) when moist; hard when dry, friable when moist; few fine and very fine concretions of calcium carbonate; calcareous.

The combined A horizons range from 10 to 24 inches in thickness, and they are calcareous in a few places. The texture of the B2 horizon ranges from clay loam to sandy clay loam,[6] and the color of that horizon ranges from grayish brown to pink. Depth to the C1ca horizon ranges from 20 to 50 inches. In places the content of visible calcium carbonate is as high as 5 percent, by volume. In a few places the surface layer of a buried soil that has blocky structure occurs below a depth of 15 inches.

BROWNFIELD SERIES

The soils of the Brownfield series are deep, well-drained, light-brown fine sands of the uplands. These soils have a subsoil of sandy clay loam and are moderately permeable. They developed in moderately sandy outwash. The Brownfield soils occur only in eroded areas with tracts of Miles loamy fine sand. Their slopes are between 3 and 5 percent.

The Brownfield soils have a surface layer that is more sandy than that of the Miles soils. Their subsoil is more clayey than that of the Springer, Likes, and Tivoli soils.

The following describes a typical profile of Brownfield fine sand 0.25 of a mile west and 150 feet south of the northeast corner of section 92, Block 23, H. & G. N. RR. survey:

Ap—0 to 18 inches, light-brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) when moist; structureless; loose both when dry and when moist; medium acid; abrupt boundary.

B2t—18 to 38 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, very coarse, prismatic and weak, fine, subangular blocky structure; very hard when dry, friable when moist; few worm casts; few fine pores; slightly acid; diffuse boundary.

C—38 to 60 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) when moist; weak, very coarse, prismatic structure; hard when dry, very friable when moist; about neutral.

The Ap horizon ranges from 4 to 24 inches in thickness. In some areas that have been deep plowed, this horizon is a mixture of fine sand and sandy clay loam. The thickness of the B2t horizon ranges from 12 to 30 inches, but it is generally about 20 inches. In some areas the profile contains a B3 horizon of light sandy clay loam. The color of the C horizon ranges from reddish brown to yellowish red. The texture of the C horizon ranges from light sandy clay loam to fine sandy loam or loamy fine sand.

GUADALUPE SERIES

In the Guadalupe series are well-drained, dark grayish-brown to brown fine sandy loams of the bottom lands. These soils are moderately permeable. They developed in calcareous, loamy and moderately sandy alluvium. A water table is at a depth of 40 to 60 inches in a few places.

The Guadalupe soils have a more sandy AC horizon than the Spur soils. They are darker colored and more clayey than the Lincoln soils. The Guadalupe soils are better drained than the Sweetwater soils.

The following describes a typical profile of Guadalupe fine sandy loam 0.2 of a mile north and 0.3 of a mile east of the southwest corner of section 4, Block 2, H. & G. N. RR. survey:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak granular structure; slightly hard when dry, very friable when moist; calcareous and moderately alkaline; abrupt boundary.

A12—6 to 16 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine and very fine, subangular blocky structure; hard when dry, very friable when moist; common fine and very fine pores; common worm casts; few fine and very fine fragments of caliche; calcareous and moderately alkaline; clear boundary.

AC—16 to 36 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; weak, coarse, prismatic and weak, fine, subangular blocky structure; very hard when dry, friable when moist; common, fine and very fine pores; common worm casts; few fine and very fine fragments of caliche; a few threads and films of calcium carbonate on the surfaces of the peds; calcareous and moderately alkaline; clear boundary.

C—36 to 60 inches, very pale brown (10YR 7/4) fine sandy loam, light yellowish brown (10YR 6/4) when moist; hard when dry, very friable when moist; few fine, soft masses of calcium carbonate; calcareous and moderately alkaline.

The combined A horizons range from 6 to 22 inches in thickness, but they are generally about 16 inches thick. In places the AC horizon contains thin layers of clay loam, loam, loamy sand, or sandy clay loam. The color of the AC horizon ranges from light brownish gray to pale brown, brown, or grayish brown, and the thickness of that horizon ranges from 8 to 30 inches.

LIKES SERIES

In the Likes series are deep, well-drained, grayish-brown to yellowish-brown loamy fine sands and sandy loams of the uplands. These soils have moderately rapid permeability. They are extensive and developed in sandy, calcareous outwash and eolian material associated with the Ogallala formation. The areas are in the valleys of streams leading from the margin of the High Plains.

The Likes soils are more sandy than the Berthoud and Mobeetie soils. They are more loamy than the Tivoli soils. The Likes soils are less reddish than the Springer

[6] Where the texture is sandy clay loam, the B2 horizon is coarser textured than normal for the Bippus series. Soils that contain such a B2 horizon may be found to be outside the range of the Bippus series when further studies are made.

soils, and they lack the distinct textural B horizon that is typical of those soils.

The following describes a typical profile of Likes loamy fine sand 0.75 of a mile west and 0.2 of a mile south of the northeast corner of section 1, J. C. Eustis survey:

A1—0 to 10 inches, grayish-brown (10YR 5/2) loamy fine sand, dark brown (10YR 3/3) when moist; weak granular structure; soft when dry, very friable when moist; many fine and very fine pores; few worm casts; few very fine concretions of calcium carbonate; calcareous and moderately alkaline; gradual boundary.

B2—10 to 30 inches, brown (10YR 5/3) loamy fine sand, brown (10YR 4/3) when moist; weak, fine, subangular blocky structure; soft when dry, very friable when moist; common fine and very fine pores; few quartz pebbles; few fine and very fine concretions of calcium carbonate; calcareous; diffuse boundary.

C—30 to 60 inches, very pale brown (10YR 7/3) fine sand, light yellowish brown (10YR 6/4) when moist; structureless; soft when dry, loose when moist; few quartz pebbles with a thin coating of calcium carbonate on the lower side; few lumps of weakly cemented, calcareous sandstone; few medium to very fine concretions of calcium carbonate; calcareous.

The A1 horizon ranges from 8 to 18 inches in thickness and from fine sand to sandy loam in texture. In a few places the color of the A1 horizon is dark grayish brown.[7] The B2 horizon ranges from 12 to 36 inches in thickness and from very pale brown to strong brown in color. Thin layers of weakly cemented sandstone occur in a few places.

LINCOLN SERIES

The soils in the Lincoln series are moderately well drained, pale-brown to grayish-brown fine sands and fine sandy loams of the bottom lands. These soils have moderately rapid permeability. They formed in calcareous sandy alluvium.

The Lincoln soils are more sandy and are lighter colored than the Spur and Guadalupe soils. They have a more sandy, lighter colored A horizon than the Sweetwater soils.

The following describes a typical profile of Lincoln loamy fine sand 0.5 of a mile north of the southwest corner of section 2, Block 1, Alexander, Crain, Harris, and Brooks survey:

A—0 to 11 inches, pale-brown (10YR 6/3) loamy fine sand, yellowish brown (10YR 5/4) when moist; weak granular structure; slightly hard when dry, very friable when moist; few, fine, hard fragments of calcium carbonate; calcareous and moderately alkaline; gradual boundary.

C—11 to 60 inches, very pale brown (10YR 7/4) loamy sand, light yellowish brown (10YR 6/4) when moist; loose when dry and moist; calcareous.

The A horizon ranges from 8 to 18 inches in thickness. The C horizon ranges from sand to loamy fine sand in texture, and it contains thin layers of loamy alluvium, coarse sand, and gravel.

MANSKER SERIES

In the Mansker series are well-drained, moderately permeable, brown to dark grayish-brown fine sandy loams and clay loams that have a weakly developed profile over loamy material. These soils developed in calcareous loamy loess and alluvium on uplands throughout most of the county. They have slopes of 1 to 8 percent.

The Mansker soils have a thinner profile than the Portales soils. They have a more clayey B2 horizon and a more conspicuous Cca horizon than the Berthoud and Mobeetie soils. The Mansker soils are similar to the Potter soils, but they have a thicker solum than those soils.

The following describes a typical profile of Mansker clay loam 0.5 of a mile west and 0.1 of a mile north of the southeast corner of section 62, Block A6, H. & G. N. RR. survey:

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate granular structure; hard when dry, friable when moist; common medium to very fine pores; common worm casts; few very fine concretions of calcium carbonate; calcareous and moderately alkaline; gradual boundary.

B2—8 to 16 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate granular structure; hard when dry, friable when moist; common medium to very fine pores; common worm casts; few threads and films of calcium carbonate on the surfaces of the peds; common medium to very fine concretions of calcium carbonate; calcareous and moderately alkaline; clear boundary.

C1ca—16 to 28 inches, very pale brown (10YR 7/3) clay loam, pale brown (10YR 6/3) when moist; weak, fine and very fine, subangular blocky structure; hard when dry, friable when moist; common medium to very fine pores; common worm casts; coarse to very fine concretions and soft masses of calcium carbonate make up about 35 percent, by volume, of the soil mass; threads and films of calcium carbonate on the surfaces of the peds; calcareous and moderately alkaline; gradual boundary.

C2—28 to 52 inches +, pink (7.5YR 8/4) clay loam, light brown (7.5YR 6/4) when moist; hard when dry, friable when moist; coarse to very fine concretions and soft masses of calcium carbonate make up about 10 percent, by volume, of the soil mass; calcareous.

The A1 horizon ranges from 5 to 12 inches in thickness. Depth to the C1ca horizon ranges from 12 to 22 inches. The content of visible calcium carbonate in the C1ca horizon ranges from 5 to 75 percent, by volume. The texture of the B2 and C1 horizons is loam or sandy clay loam in a few places.

MILES SERIES

The soils of the Miles series are deep, well-drained, brown fine sandy loams and loamy fine sands of the uplands in the central and eastern parts of the county. These soils are moderately permeable. They developed in moderately sandy outwash. The slopes are between 0 and 5 percent. In this county the Miles soils are slightly less reddish than the Miles soils in areas to the south and east of this county on the Rolling Plains. Gray County is believed to be near the northern limit where Miles soils occur in this part of Texas.

The Miles soils have a more loamy surface layer than the Brownfield soils and more clayey B horizons than the Springer soils. They are noncalcareous and are more clayey and more reddish than the Likes soils. The Miles soils are more sandy throughout and have more friable B horizons than the Olton soils. They have a thinner, more reddish surface layer and a more distinct textural B horizon than the Bippus soils.

[7] In Gray County some areas are mapped as Likes loamy fine sand that have a darker colored A1 horizon than is allowable for the range of characteristics defined for the Likes series.

The following describes a typical profile of Miles fine sandy loam 0.3 of a mile south and 0.3 of a mile west of the northeast corner of section 11, Block 25, H. & G. N. RR. survey:

A1—0 to 5 inches, brown (7.5YR 4/3) fine sandy loam, dark brown (7.5YR 3/3) when moist; moderate, very fine, granular and subangular blocky structure; slightly hard when dry, very friable when moist; many medium to very fine pores; many worm casts; noncalcareous and medium acid; clear boundary.

B1—5 to 11 inches, brown (7.5YR 4/3) light sandy clay loam, dark brown (7.5YR 3/3) when moist; moderate, very coarse, prismatic and weak, fine, subangular blocky structure; very hard when dry, friable when moist; common medium to very fine pores; many worm casts; noncalcareous and slightly acid to neutral; gradual boundary.

B2t—11 to 30 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, very coarse, prismatic and weak, medium and fine, subangular blocky structure; very hard when dry; friable when moist; common fine and very fine pores; common worm casts; a few quartz pebbles as much as one-fourth of an inch in diameter; noncalcareous and neutral; diffuse boundary.

B3—30 to 50 inches, yellowish-red (5YR 5/5) sandy clay loam that grades to fine sandy loam, yellowish red (5YR 4/5) when moist; hard when dry, friable when moist; noncalcareous and neutral; gradual boundary.

C—50 to 62 inches +, reddish-yellow (5YR 6/5) loamy fine sand, yellowish red (5YR 5/5) when moist; slightly hard when dry, very friable when moist; noncalcareous and neutral.

The A1 horizon ranges from 4 to 22 inches in thickness; the loamy fine sand type has a thicker surface layer than the fine sandy loam type. The color of the A horizon is dark grayish brown in a few nearly level places. The combined thickness of the B horizons ranges from 12 to 48 inches, but it is generally about 30 inches. The color of the B horizon ranges from dark reddish brown to yellowish red. An inconspicuous Cca horizon occurs in a few areas. In a few places caliche of the Ogallala formation occurs below a depth of 24 inches.

MOBEETIE SERIES

The Mobeetie series is made up of well-drained, deep, dark grayish-brown, grayish-brown, and brown fine sandy loams of the uplands. These soils have moderately rapid permeability. They developed in calcareous, moderately sandy alluvium washed down from the slopes above. These soils are most extensive along the rolling and dissected margin of the High Plains. Their slopes range from 1 to 10 percent.

The Mobeetie soils have a calcareous surface layer that is thinner than that of the Bippus soils, and they also have a more sandy subsoil. They are more sandy than the Berthoud soils and are more clayey than the Likes soils. The Mobeetie soils are more sandy and have less calcium carbonate in their subsoil than the Mansker soils.

The following describes a typical profile of Mobeetie fine sandy loam 0.65 of a mile west and 0.5 of a mile south of the northeast corner of section 56, Block B2, H. & G.N. RR. survey:

A1—0 to 10 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine and very fine, granular structure; hard when dry, very friable when moist; common fine and very fine pores; common worm casts; few fine and very fine concretions of calcium carbonate; weakly calcareous and mildly alkaline; gradual boundary.

B2—10 to 30 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; moderate, coarse, prismatic and moderate, fine, subangular blocky structure; hard when dry, very friable when moist; many medium to very fine pores; many worm casts; few threads and films of calcium carbonate on the surfaces of the peds; few quartz pebbles; few medium to very fine concretions of calcium carbonate; very strongly calcareous; diffuse boundary.

C1ca—30 to 46 inches, pale-brown (10YR 6/3) fine sandy loam, yellowish brown (10YR 5/4) when moist; weak, coarse, prismatic and weak, fine, subangular blocky structure; hard when dry, very friable when moist; many medium to very fine pores; many worm casts; many threads and films of calcium carbonate on the surfaces of the peds; few quartz pebbles; common, medium to very fine concretions of calcium carbonate; very strongly calcareous; diffuse boundary.

C2—46 to 72 inches, very pale brown (10YR 7/3) fine sandy loam, light yellowish brown (10YR 6/4) when moist; weak, fine, subangular blocky structure; hard when dry, very friable when moist; many medium to very fine pores; few worm casts; few threads and films of calcium carbonate on the surfaces of the peds; few quartz pebbles that have a thin coating of calcium carbonate on the lower side; common medium to very fine concretions of calcium carbonate; very strongly calcareous.

The thickness of the A1 horizon ranges from 5 to 12 inches. The upper part of this horizon is noncalcareous in a few places. The texture throughout the profile is generally fine sandy loam, but it is a light loam in some places. The color of the B2 horizon ranges from grayish brown or brown to very pale brown. The content of visible calcium carbonate in the C1ca horizon ranges from 1 to 5 percent, by volume.

OLTON SERIES

In the Olton series are deep, well-drained, brown to dark grayish-brown clay loams and loams of the uplands. These soils have moderately slow permeability. They developed in calcareous loamy alluvium and loess in rolling areas at the edge and just below the edge of the High Plains. They also occur in slightly concave and slightly convex areas of the High Plains.

The Olton soils are more reddish and less clayey than the Pullman soils, and they are more clayey than the Miles soils. They are more reddish than the Bippus and Zita soils, and they have a more distinct textural B horizon.

The following describes a typical profile of Olton clay loam 0.55 of a mile south and 50 feet west of the northeast corner of section 23, Block M2, H. & G.N. RR. survey:

A1—0 to 6 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) when moist; moderate granular structure; very hard when dry, friable when moist; few very fine pores; common worm casts; noncalcareous and neutral; clear boundary.

B1—6 to 11 inches, brown (7.5YR 4/3) clay loam, dark brown (7.5YR 3/3) when moist; moderate, fine, subangular blocky structure; very hard when dry, firm when moist; common very fine pores; common worm casts; noncalcareous and neutral; gradual boundary.

B2t—11 to 22 inches, brown (7.5YR 4/3) heavy clay loam, dark brown (7.5YR 3/3) when moist; moderate, medium, blocky structure; extremely hard when dry, firm when moist; common very fine pores; few worm casts; clay films on the surfaces of the peds; noncalcareous and mildly alkaline; gradual boundary.

B3—22 to 38 inches, brown (7.5YR 5/4) clay loam, dark brown (7.5YR 3/4) when moist; moderate, coarse,

blocky structure; very hard when dry, firm when moist; few fine and very fine, soft masses of calcium carbonate; common fine and very fine pores; few worm casts; thin clay films on the surfaces of the peds; calcareous and moderately alkaline; gradual boundary.

C1ca—38 to 50 inches, reddish-yellow (5YR 6/5) clay loam, yellowish red (5YR 5/5) when moist; very hard when dry, friable when moist; many coarse to very fine, soft masses and very fine concretions of calcium carbonate that make up about 40 percent, by volume, of the soil mass; calcareous; gradual boundary.

C2—50 to 60 inches +, yellowish-red (5YR 5/6) clay loam, yellowish red (5YR 4/6) when moist; very hard when dry, friable when moist; common, coarse, soft masses of calcium carbonate; calcareous.

The A1 horizon ranges from 4 to 12 inches in thickness. The combined B horizons range from 20 to 50 inches in thickness and from reddish brown to dark grayish brown in color. In some places the solum is thinner than the one described, and the B1 horizon is lacking in those areas. In some places the B1 and B3 horizons are sandy clay loam. The content of calcium carbonate in the C1ca horizon in some areas is as much as 60 percent, by volume.

PORTALES SERIES

The soils of the Portales series are deep, calcareous, brown to dark grayish-brown clay loams that are well drained and moderately permeable. These soils developed in calcareous loamy material, probably loess. They are on uplands of the High Plains. Their slopes are between 0 and 3 percent.

The Portales soils have a profile similar to that of the Zita soils, but they have a lighter colored, calcareous surface layer. They have a thicker solum than the Mansker soils. The Portales soils have a less compact and less clayey subsoil than the Pullman soils, and they are calcareous to the surface.

The following describes a typical profile of Portales clay loam in a cultivated field 450 feet west and 50 feet north of the southeast corner of section 145, Block B2, H. & G.N. RR. survey:

Ap—0 to 4 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard when dry, very friable when moist; calcareous and moderately alkaline; abrupt boundary.

A1—4 to 10 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium and fine, subangular blocky structure; hard when dry, friable when moist; common fine and very fine pores; few worm casts; few threads and films of calcium carbonate on the surfaces of the peds; calcareous and moderately alkaline; gradual boundary.

B2—10 to 20 inches, brown (7.5YR 5/4) clay loam, brown (7.5YR 4/4) when moist; moderate, fine, subangular blocky structure; very hard when dry, friable when moist; common medium and fine pores; few worm casts; few fine and very fine concretions of calcium carbonate; calcareous and moderately alkaline; gradual boundary.

C1ca—20 to 34 inches, brown (7.5YR 5/4) clay loam, brown (7.5YR 4/4) when moist; moderate, medium and fine, subangular blocky structure; very hard when dry, friable when moist; common medium to very fine pores; few worm casts; medium to very fine soft masses of calcium carbonate make up about 7 percent, by volume, of the soil mass; few threads and films of calcium carbonate on the surfaces of the peds and in pores; calcareous and moderately alkaline; gradual boundary.

C2—34 to 60 inches, brown (7.5YR 5/4) clay loam, brown (7.5YR 4/4) when moist; weak, medium, subangular blocky structure; very hard when dry, friable when moist; few very fine pores; few very fine concretions of calcium carbonate, and a few threads and films of calcium carbonate on the surfaces of the peds and in pores; calcareous and moderately alkaline.

The combined A horizons range from 6 to 14 inches in thickness. The uppermost 6 inches of soil material is noncalcareous in a few places. The thickness of the B2 horizon ranges from 10 to 24 inches. Depth to the C1ca horizon ranges from 18 to 30 inches. The content of visible calcium carbonate in the C1ca horizon ranges from 3 to 30 percent, by volume. The thickness of that horizon ranges from 8 to 36 inches.

POTTER SERIES

In the Potter series are well-drained, dark grayish-brown to pale-brown fine sandy loams to gravelly clay loams or gravelly loams that are very shallow over caliche. These soils formed in material that ranges from indurated caliche to a mixture of caliche and calcareous material. They are mainly on ridges in the uplands along dissected margins of the High Plains.

The Potter soils have a thinner solum and are more gravelly than the Mansker soils. Their profile is similar to that of the Quinlan soils, but they developed in material weathered from caliche instead of in material weathered from the red beds.

The following describes a typical profile of Potter gravelly loam 0.4 of a mile west and 50 feet north of the southeast corner of section 62, Block A6, H. & G.N. RR. survey:

A—0 to 9 inches, dark grayish-brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) when moist; moderate, very fine, granular structure; hard when dry, very friable when moist; common fine and very fine pores; common worm casts; many fragments of caliche; calcareous and moderately alkaline; diffuse boundary.

C—9 to 15 inches +, pink (7.5YR 8/4), hard caliche about 20 percent, by volume, of the upper part is soil material, but the content of soil material decreases with increasing depth; hard flaggy caliche at a depth of 15 inches.

Depth to the C horizon ranges from 4 to 12 inches. The content of visible calcium carbonate in the C horizon is more than 30 percent, by volume.

PULLMAN SERIES

The soils of the Pullman series are deep, well-drained brown to dark grayish-brown clay loams of the uplands (fig. 21). These soils are slowly permeable. They developed in calcareous loamy material, probably loess. These soils are extensive on the High Plains. Their slopes are generally less than 1 percent, but they range from 0 to 2 percent.

The Pullman soils have a less clayey surface layer and are less grayish throughout than the Roscoe soils. They have a distinct textural B horizon that is lacking in the Roscoe soils. Their profile is similar to that of the Olton soils, but their subsoil is more compact and clayey. The Pullman soils have a blocky, more clayey and compact, and less limy subsoil than the Zita and Portales soils.

The following describes a typical profile of Pullman clay loam in a cultivated field 0.45 of a mile west and 50

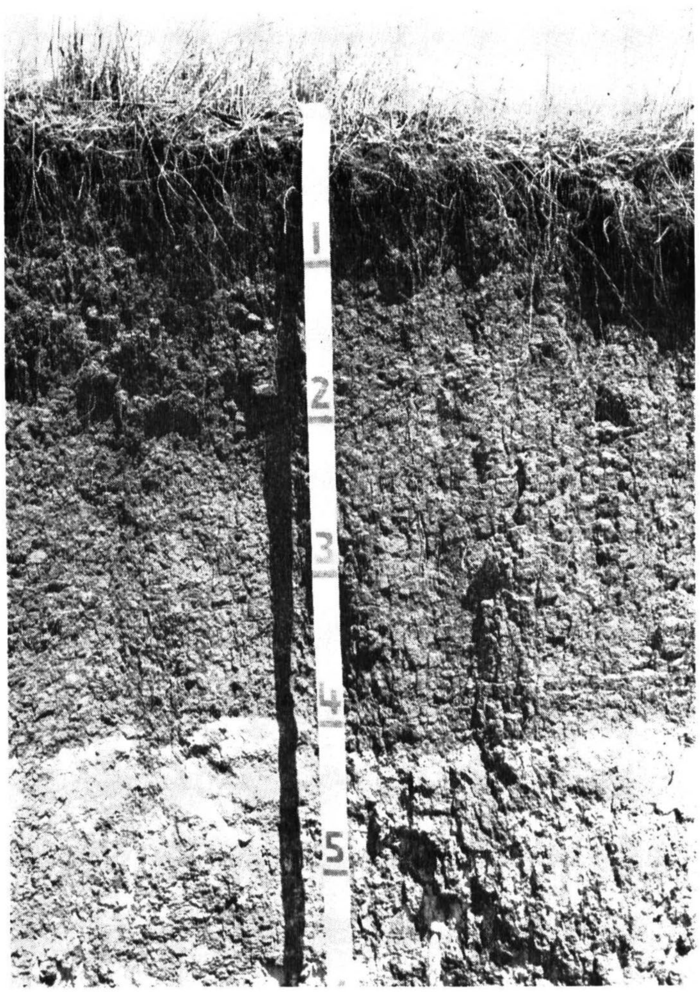

Figure 21.—**Profile of Pullman clay loam.**

feet south of the northeast corner of section 114, Block B2, H. & G.N. RR. survey:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak granular structure; hard when dry, friable when moist; noncalcareous and neutral; abrupt boundary.

B21t—6 to 12 inches, dark grayish-brown (10YR 4/2) clay, dark brown (10YR 3/3) when moist; moderate, fine, blocky and subangular blocky structure; extremely hard when dry, very firm when moist; few very fine pores; clay films on the surfaces of the peds; noncalcareous and mildly alkaline; gradual boundary.

B22t—12 to 30 inches, dark grayish-brown (10YR 4/2) clay, dark brown (10YR 3/3) when moist; moderate, coarse and medium, blocky structure; extremely hard when dry, very firm when moist; few very fine pores; clay films on the surfaces of the peds; noncalcareous and mildly to moderately alkaline; diffuse boundary.

B23t—30 to 45 inches, brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) when moist; weak, coarse, blocky structure; extremely hard when dry, firm when moist; few very fine pores; clay films on the surfaces of the peds; few very fine concretions of calcium carbonate; calcareous and moderately alkaline; gradual boundary.

B2tb—45 to 78 inches, brown (7.5YR 5/4) clay loam, brown (7.5YR 4/4) when moist; strong, medium, blocky structure; very hard when dry, firm when moist; few very fine pores; thin, continuous clay films on the surfaces of the peds; few films of iron and manganese on the surfaces of the peds; weakly calcareous; gradual boundary.

Ccab—78 to 90 inches +, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) when moist; moderate, coarse and medium, subangular blocky structure; very hard when dry, friable when moist; common medium to very fine pores; many soft, coarse to very fine concretions of calcium carbonate make up about 25 percent, by volume, of the soil mass; calcareous.

The A horizon ranges from 4 to 8 inches in thickness, and its texture is silty clay loam or light clay in a few places. This horizon is slightly acid in a few places, but it is generally neutral. It has a hue of 7.5YR where these soils occur near the edge of the High Plains and in areas where the slopes are greater than 0.5 percent. In some places the B2tb horizon is absent. Depth to the B2tb horizon, where present, ranges from 36 to 60 inches. Depth to the Ccab horizon ranges from 24 to 96 inches, but it is about 72 inches in most places.

QUINLAN SERIES

In the Quinlan series are well-drained, reddish-brown to yellowish-red loams to very fine sandy loams that are shallow over red-bed material. These soils formed in medium-textured sediments of the red beds. They occur along ridges in areas underlain by red beds in the eastern part of the county.

The Quinlan soils are more shallow and have a less well-developed profile than the Woodward soils. Their profile is similar to that of the Potter soils, but it is shallow over red-bed material rather than caliche.

The following describes a typical profile of Quinlan loam 0.2 of a mile east of the northwest corner of section 2, Block 26, H. & G.N. RR. survey:

A1—0 to 8 inches, yellowish-red (5YR 5/6) loam, yellowish red (5YR 4/6) when moist; weak, medium and fine, granular structure; hard when dry, friable when moist; few fragments of red-bed packsand; calcareous and moderately alkaline; gradual boundary.

C—8 to 24 inches, reddish-yellow (5YR 6/6), fine-grained, weakly cemented red-bed sandstone, yellowish red (5/6) when dry, friable when moist; calcareous and moderately alkaline.

The A1 horizon ranges from 3 to 12 inches in thickness. The lower boundary of that horizon ranges from clear to diffuse. The texture of the sandstone or packsand from the red beds is loam or very fine sandy loam, and the color of that material is red in some places instead of yellowish red.

RANDALL SERIES

In the Randall series are deep, gray to dark-gray clays that are poorly drained. These soils are very slowly permeable. They formed in clayey sediments on the bottoms of intermittent lakes on the High Plains.

The Randall soils are lighter colored and more poorly drained than the Roscoe soils. Their profile is similar to that of the Pullman soils, but the Randall soils are more grayish, are more poorly drained, and have a thicker, more clayey surface layer than those soils.

The following describes a typical profile of Randall clay 250 feet east and 40 feet south of the northwest corner of section 84, Block M2, H. & G.N. RR. survey:

A1—0 to 10 inches, gray (2.5Y 5/1) clay, very dark gray (2.5Y 3/1) when moist; weak, coarse and medium, blocky structure; extremely hard when dry, very firm when moist; few very fine pores; noncalcareous and neutral; diffuse boundary.

AC—10 to 40 inches, gray (2.5Y 5/1) clay, dark gray (2.5Y 4/1) when moist; weak, coarse, blocky structure; extremely hard when dry, very firm when moist; few very fine pores; noncalcareous and neutral to mildly alkaline; diffuse boundary.

C—40 to 60 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) when moist; extremely hard when dry, very firm when moist; noncalcareous and moderately alkaline.

The A1 horizon ranges from 10 to 18 inches in thickness. It has a texture of silty clay loam in a few places and is calcareous in a few places. The AC horizon is mottled in some places. Depth to the C horizon ranges from 36 to 48 inches. The colors of this dry soil range from gray to dark grayish brown. In some places buried strata of calcareous, brownish-colored material occur in the substratum.

ROSCOE SERIES

The soils of the Roscoe series are deep, well-drained, gray to very dark grayish-brown clays of the uplands. These soils are slowly permeable. They formed in calcareous, clayey material, probably alluvium and loess. These soils are on nearly level benches around intermittent lakes on the High Plains.

The Roscoe soils have a thicker, more clayey surface layer than the Pullman soils, but they are more grayish and have a weaker grade of structure than those soils. They are better drained than the Randall soils.

The following describes a typical profile of Roscoe clay 0.65 of a mile south and 50 feet west of the northeast corner of section 138, Block B2, H. & G.N. RR. survey:

A—0 to 15 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; moderate, fine and very fine, subangular blocky structure; very hard when dry, very firm when moist; few very fine pores; few worm casts; noncalcareous and moderately alkaline; gradual boundary.

AC1—15 to 32 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) when moist; weak, medium and fine, blocky and irregular blocky structure; extremely hard when dry, extremely firm when moist; few very fine pores; calcareous and moderately alkaline; diffuse boundary.

AC2—32 to 45 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) when moist; weak, coarse and medium, blocky structure; extremely hard when dry, extremely firm when moist; few very fine pores; few very fine concretions of calcium carbonate; calcareous and moderately alkaline; diffuse boundary.

C—45 to 62 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) when moist; extremely hard when dry, very firm when moist; few very fine concretions and soft masses of calcium carbonate; calcareous and moderately alkaline.

The A horizon ranges from 10 to 20 inches in thickness, and it is calcareous in a few places. The combined AC horizons range from 20 to 40 inches in thickness and from brown to dark gray in color. The structure of the moist AC horizons is weak, but the structure when these horizons are dry appears to be moderate to strong. Depth to the C horizon ranges from 30 to 55 inches.

SPRINGER SERIES

In the Springer series are deep, well-drained, brown loamy fine sands of the uplands. These soils have moderately rapid permeability. They developed in weakly calcareous sandy outwash and eolian material and are extensive in the central and eastern parts of the county. The slopes range from 0 to 5 percent.

The Springer soils have a more sandy B horizon than the Miles and Brownfield soils. They have a thicker, coarser textured, more reddish surface layer than the Mobeetie soils, and their surface layer is noncalcareous, Also, they have a more distinct textural B horizon than the Mobeetie soils. The Springer soils have a profile similar to that of the Likes soils, but they are more reddish than the Likes soils and are noncalcareous. Also, they have a more distinct textural B horizon.

The following describes a typical profile of Springer loamy fine sand 0.1 of a mile south and 100 feet west of the northeast corner of section 31, Block 25, H. & G. N. RR. survey:

A11—0 to 7 inches, brown (7.5YR 5/3) loamy fine sand, dark brown (7.5YR 3/3) when moist; weak granular and subangular blocky structure; slightly hard when dry, very friable when moist; few fine pores; common worm casts; noncalcareous and slightly acid; gradual boundary.

A12—7 to 16 inches, brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) when moist; weak, medium and fine, subangular blocky structure; soft when dry, very friable when moist; few fine pores; common worm casts; few quartz pebbles; noncalcareous and slightly acid; clear boundary.

B2t—16 to 35 inches, reddish-brown (5YR 5/5) fine sandy loam, reddish brown (5YR 4/5) when moist; weak, very coarse, prismatic and weak, medium and fine, subangular blocky structure; hard when dry, friable when moist; common medium and fine pores; common worm casts; few quartz pebbles; noncalcareous and slightly acid; diffuse boundary.

B3—35 to 45 inches, reddish-yellow (5YR 6/6) fine sandy loam, yellowish red (5YR 4/6) when moist; moderate, coarse, prismatic and weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist; few fine pores; few quartz pebbles; noncalcareous and slightly acid or neutral; diffuse boundary.

C—45 to 60 inches +, reddish-yellow (5YR 6/6) light fine sandy loam, yellowish red (5YR 5/6) when moist; slightly hard when dry, very friable when moist; noncalcareous and neutral.

The combined A horizons range from 5 to 20 inches in thickness, and the combined B horizons range from 12 to 48 inches in thickness. The color throughout the profile ranges from reddish brown or brown to reddish yellow. In some places a B1 horizon is present, and in other places the B3 horizon is absent. A weakly defined Ccs horizon occurs in a few places.

SPUR SERIES

The Spur series is made up of well-drained, grayish-brown or dark grayish-brown fine sandy loams to clay loams of the bottom lands. These soils are moderately permeable. They formed in brownish, calcareous loamy and sandy alluvium. A water table is at a depth of 4 to 6 feet in a few places.

The Spur soils are darker colored and more clayey than the Lincoln soils. They are better drained and have a more clayey subsoil than the Sweetwater soils. The profile of the Spur soils is similar to that of the Bippus soils, but the Spur soils have a calcareous surface layer and lack a distinct Ccs horizon. They are more clayey below the surface layer than the Guadalupe soils.

The following describes a typical profile of Spur clay loam 0.25 of a mile east and 100 feet north of the southwest corner of section 48, Block A6, H. & G. N. RR. survey:

A1—0 to 15 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, coarse, prismatic and moderate, fine, subangular blocky structure; very hard when dry, friable when moist; common medium to very fine pores; many worm casts; calcareous and moderately alkaline; gradual boundary.

AC—15 to 45 inches, brown (10YR 5/3) clay loam, brown (10YR 4/3) when moist; moderate, coarse, prismatic and weak, fine, subangular blocky structure; very hard when dry, friable when moist; many medium to very fine pores; common worm casts; threads and films of calcium carbonate on the surfaces of the peds; calcareous and moderately alkaline; clear boundary.

C—45 to 55 inches, pale-brown (10YR 6/3) sandy clay loam, brown (10YR 4/3) when moist; weak, coarse, prismatic and weak, medium and fine, subangular blocky structure; hard when dry, very friable when moist; many medium to very fine pores; few worm casts; few threads and films of calcium carbonate on the surfaces of the peds; calcareous.

The A1 horizon ranges from 6 to 18 inches in thickness. The texture of the AC horizon is sandy clay loam or loam in some places. The color of the profile when the soil material is dry ranges from dark grayish brown to brown, pale brown, or light yellowish brown. Depth to the C horizon ranges from 24 to about 60 inches, but it is generally about 45 inches.

SWEETWATER SERIES

In the Sweetwater series are poorly drained, very dark gray to light brownish-gray silty clay loams to fine sandy loams of the bottom lands. These soils formed in calcareous sandy alluvium in wet areas. They are gleyed and have a high content of organic matter in the surface layer. A water table is at a depth of about 20 inches.

The Sweetwater soils are more poorly drained and have more sandy material below the surface layer than the Spur and Guadalupe soils. Their profile is similar to that of the Lincoln soils, but they have a darker, more clayey surface layer and a high water table.

The following describes a typical profile of Sweetwater silty clay loam 0.3 of a mile north and 100 feet east of the southwest corner of section 24, Block 25, H. & G. N. RR. survey:

A—0 to 10 inches, gray (10YR 5/1) light silty clay loam, very dark gray (10YR 3/1) when moist; moderate, fine, subangular blocky structure; very hard when dry, friable when moist; common coarse to very fine pores; many worm casts; few, faint, yellowish-brown mottles; calcareous and moderately alkaline; gradual boundary.

AC—10 to 20 inches, gray (2.5Y 6/1) sandy clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic and weak, fine, subangular blocky structure; very hard when dry, friable when moist; many coarse to very fine pores; many worm casts; common, distinct, medium to very fine, yellowish-brown mottles; calcareous and moderately alkaline; diffuse boundary.

C—20 to 62 inches, light brownish-gray (2.5Y 6/2) loamy fine sand, dark grayish brown (2.5Y 4/2) when moist; very hard when dry, very friable when moist; few very fine concretions of calcium carbonate in the lower part; calcareous and moderately alkaline.

The A horizon ranges from 10 to 15 inches in thickness. The AC horizon ranges from fine sand to sandy clay loam in texture. The contrast of the mottles ranges from faint to prominent. Strata of loam or clay loam, as much as 6 inches thick, are common in the substratum.

TIVOLI SERIES

The Tivoli series is made up of deep, excessively drained, brown fine sands and loamy fine sands of the uplands. These soils are rapidly permeable. They formed in eolian sands and outwash in the eastern part of the county. The areas occur where streams lead from the margin of the High Plains.

The Tivoli soils are more sandy than the Miles, Springer, and Likes soils.

The following describes a typical profile of Tivoli fine sand 0.3 of a mile west and 200 feet south of the northeast corner of section 5, Block 26, H. & G. N. RR. survey:

A—0 to 8 inches, brown (10YR 5/3) fine sand, brown (10YR 4/3) when moist; weak granular structure; loose when dry and when moist; noncalcareous and about neutral; diffuse boundary.

C—8 to 60 inches +, reddish-yellow (7.5YR 6/5) fine sand, strong brown (7.5YR 5/5) when moist; single grain; loose when dry and when moist; noncalcareous and neutral.

The A horizon ranges from 5 to 9 inches in thickness, and its texture is light loamy fine sand or loamy sand in a few places. The color of the C horizon ranges from reddish yellow to light brown, strong brown, or pale brown. Fragments or layers of weakly cemented sandstone occur in the C horizon in some areas. In some places these soils are calcareous.

WOODWARD SERIES

In the Woodward series are deep, well-drained, reddish-brown loams to very fine sandy loams of the uplands. These soils have moderately rapid permeability. They formed in medium-textured sediments of the Permian red beds along the rivers and creeks in the eastern part of the county.

The Woodward soils are more reddish and more silty than the Berthoud and Mobeetie soils. The Woodward soils are darker to a greater depth than the Quinlan soils.

The following describes a typical profile of Woodward very fine sandy loam 0.2 of a mile east and 100 feet south of the northwest corner of section 2, Block 26, H. & G. N. RR. survey:

A—0 to 9 inches, reddish-brown (5YR 5/4) very fine sandy loam, dark reddish brown (5YR 3/4) when moist; weak, fine, granular structure; very hard when dry, friable when moist; calcareous and moderately alkaline; gradual boundary.

B2—9 to 25 inches, reddish-brown (5YR 5/4) very fine sandy loam, dark reddish brown (5YR 3/4) when moist; moderate, fine, subangular blocky and moderate, coarse, prismatic structure; very hard when dry, friable when moist; common medium to very fine pores; many worm casts; threads and films of calcium carbonate on the surfaces of the peds; few medium to very fine fragments of caliche and shale; calcareous and moderately alkaline; diffuse boundary.

C—25 to 60 inches, light-red (2.5YR 6/6), fine-grained, weakly cemented sandstone of the red beds, red (2.5YR 4/6) when moist; massive; extremely hard when dry, friable when moist; calcareous and moderately alkaline.

The A horizon ranges from 6 to 15 inches in thickness, and the B2 horizon ranges from 12 to 30 inches in thickness. The color throughout, when the profile is dry, ranges from reddish brown to light red. The texture ranges

from very fine sandy loam to light clay loam. A weakly developed Cca horizon occurs in a few places. Depth to the C horizon ranges from 18 to 40 inches.

ZITA SERIES

In the Zita series are deep, well-drained, dark grayish-brown to very dark grayish-brown clay loams of the uplands. These soils are moderately permeable. They formed in calcareous loamy material, probably loess, on the High Plains. The slopes range from 0 to 3 percent.

The Zita soils have a noncalcareous surface layer that is darker than that of the Portales soils. The soil material below the surface layer is less compact and less clayey than comparable material in the Pullman and Olton soils. The profile of the Zita soils is similar to that of the Mansker soils, but their surface layer is noncalcareous and they have a thicker solum.

The following describes a typical profile of Zita clay loam in a cultivated field 0.1 of a mile east and 50 feet north of the southwest corner of section 158, Block B2, H. & G. N. RR. survey:

Ap—0 to 4 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak granular structure; very hard when dry, friable when moist; noncalcareous and neutral; abrupt boundary.

A1—4 to 12 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, subangular blocky structure; very hard when dry, friable when moist; common fine and very fine pores; common worm casts; the peds have a shine on their surfaces in a few places; noncalcareous and neutral; gradual boundary.

B2—12 to 24 inches, brown (10YR 5/3) clay loam, brown (10YR 4/3) when moist; moderate, fine, subangular blocky and weak, coarse, prismatic structure; very hard when dry, friable when moist; common fine and very fine pores; common worm casts; few clay films on the surfaces of the peds; few fine and very fine, hard concretions of calcium carbonate; calcareous and moderately alkaline; diffuse boundary.

Cca—24 to 45 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) when moist; weak, medium, subangular blocky and weak, coarse, prismatic structure; very hard when dry, friable when moist; few medium to very fine pores; few worm casts; few dark streaks in the matrix; few very fine concretions of calcium carbonate; 15 to 20 percent, by volume, soft masses of calcium carbonate; calcareous and moderately alkaline; diffuse boundary.

C—45 to 62 inches +, reddish-yellow (7.5YR 6/5) clay loam, strong brown (7.5YR 4/5) when moist; very hard when dry, friable when moist; common medium to very fine pores; few worm casts; common, coarse, soft masses of calcium carbonate; calcareous and moderately alkaline.

The combined A horizons range from 8 to 15 inches in thickness, and the B2 horizon ranges from 5 to 24 inches in thickness. The texture of the A horizons is mainly clay loam, but it is silty clay loam in a few places. Depth to the Cca horizon ranges from 20 to 36 inches.

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Glossary

Aggregate, soil. A mass or cluster of many soil particles held together in a granule, clod, block, or prism. See also Structure, soil.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Blowout. An excavation produced by wind action in loose soil, usually sand.

Calcareous soil. A soil that contains enough calcium carbonate to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. Also, a soil that is alkaline in reaction because of the presence of free calcium carbonate. The pH is generally more than 7.8. See also Reaction, soil.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. It may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt. See also Texture, soil.

Clay film. A thin coating of clay that has been deposited on the surface of a soil aggregate.

Concave slope. A land surface that is curved like the interior of a sphere or arch.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Convex slope. A land surface that is curved like the exterior of a sphere or arch.

Diversion terrace. A ridge of earth that is built to direct runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Eolian deposits. Soil parent material accumulated through wind action; commonly refers to sandy material in dunes.

Field terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed.

Gilgai. Microrelief of clays that have a high coefficient of expansion and contraction with changes in moisture; usually a succession of microbasins and microknolls, in nearly level areas, or of microvalleys and microridges that run with the slope.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. See also Profile, soil; Surface layer; Subsoil; Solum.

Hummocky. Irregular or choppy topography where there are small dunes or mounds 3 to 10 feet high and a gradient of 3 to 8 percent.

Loess. A fine-grained eolian deposit consisting dominantly of silt-sized particles transported by wind.

Mottles. Spots or blotches differing from the rest of the soil mass in color.

Munsell notation. A system of designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color that has a hue of 10YR, a value of 6, and a chroma of 4.

Outwash. Cross-bedded gravel, sand, silt, and clay deposited by melt water as it flowed from glacial ice; overwash. In this county outwash refers to soil material that was washed from areas in the High Plains and Rocky Mountains by melt water carried in streams, and deposited on the Permian red beds during the Pleistocene epoch.

Parent material. The weathered rock or partly weathered soil material from which a soil has formed; horizon C in the soil profile.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *Very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Permian. A period of geologic time; refers to geologic material deposited during the Permian period.

Playas. Undrained basins that are generally dry but that contain water for periods following rains.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. See also Horizon, soil.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values or in words, as follows:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Relief. The elevations or inequalities of a land surface, considered collectively; also, the difference in elevation between the hilltops or summits, and the lowlands of a region.

Sand. As a soil separate, individual rock or mineral fragments 0.05 to 2.0 millimeters in diameter. Most sand grains are quartz, but sand may be of any mineral composition. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay. See also Texture, soil.

Silt. As a soil separate, individual mineral particles 0.002 millimeter to 0.05 millimeter in diameter. As a textural class, soil that is 80 percent or more silt and less than 12 percent clay. See also Texture, soil.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief, over a period of time.

Solum. The upper part of the soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soils includes the A and B horizons. See also Horizon, soil.

Structure, soil. The arrangement of primary soil particles into compound particles, or clusters, that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular.* Structureless soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many claypans and hardpans). See also Aggregate, soil.

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth. See also Horizon, soil.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. See also Horizon, soil.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportions of fine particles, are as follows: Sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse" or "very fine." See also Clay; Sand; and Silt.

Undulating. Topography that rises or falls like waves; characterized by a rhythmic succession of wavelike crests and hollows or of higher and lower levels. In this county the rises are less than 5 feet high and have a gradient of less than 3 percent.

Winnow. The removal of clay and silt particles from the soil by strong winds. The coarser textured particles are left, and the soil becomes more sandy and highly erodible.

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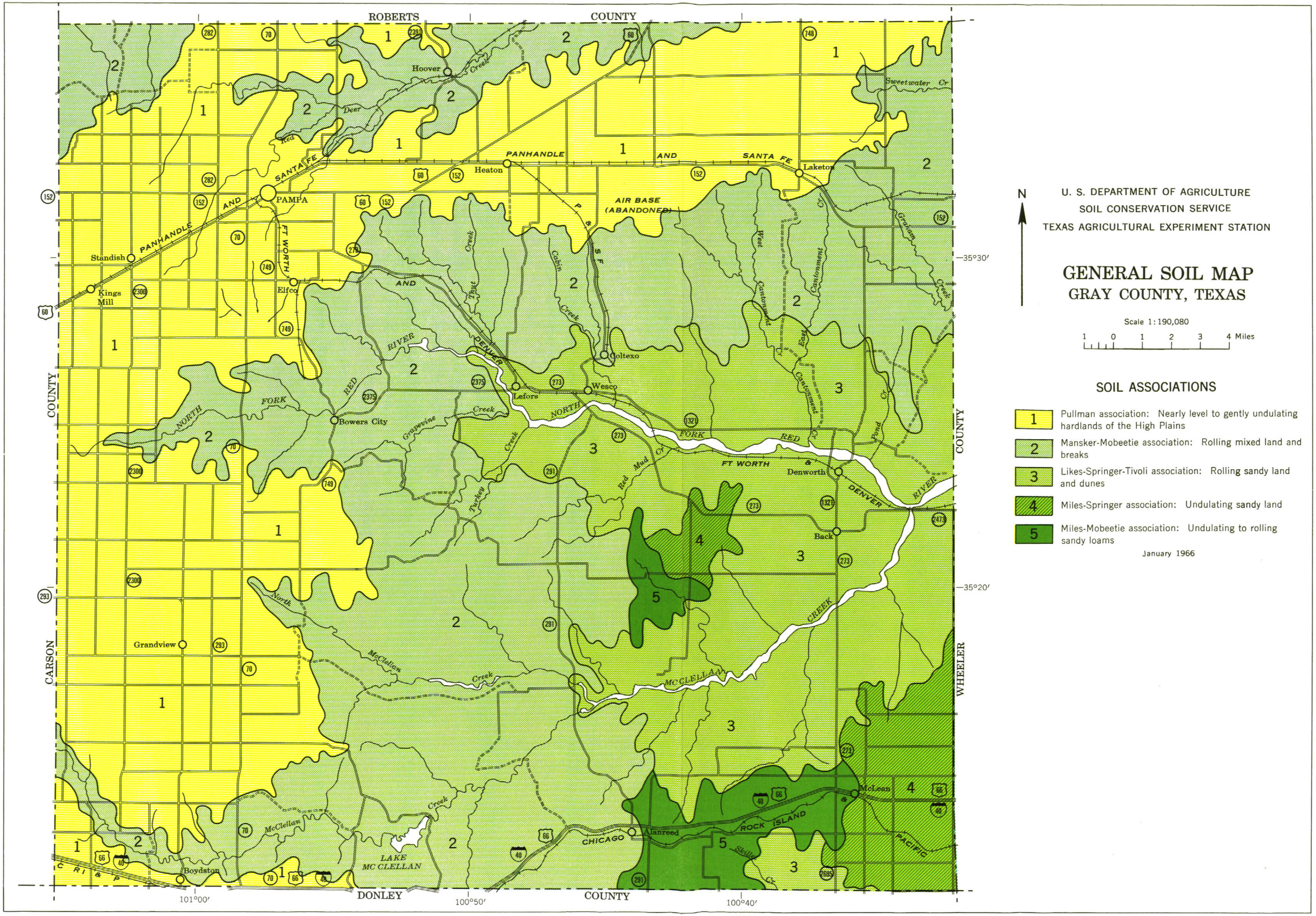


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEXAS AGRICULTURAL EXPERIMENT STATION
GENERAL SOIL MAP
GRAY COUNTY, TEXAS
N
Scale 1:190,080
1 0 1 2 3 4 Miles
SOIL ASSOCIATIONS
1 Pullman association: Nearly level to gently undulating hardlands of the High Plains
2 Mansker-Mobeetie association: Rolling mixed land and breaks
3 Likes-Springer-Tivoli association: Rolling sandy land and dunes
4 Miles-Springer association: Undulating sandy land
5 Miles-Mobeetie association: Undulating to rolling sandy loams
January 1966
ROBERTS COUNTY
CARSON COUNTY
WHEELER COUNTY
DONLEY COUNTY
35°30′
35°20′
101°00′
100°50′
100°40′
PAMPA
Hoover
Heaton
Laketon
Standish
Kings Mill
Elfco
Coltexo
Lefors
Wesco
Bowers City
Denworth
Back
Grandview
Alanreed
McLean
Boydston
PANHANDLE AND SANTA FE
FT WORTH AND DENVER
CHICAGO ROCK ISLAND & PACIFIC
AIR BASE (ABANDONED)
P & S F
C RI & P
NORTH FORK RED RIVER
McCLELLAN CREEK
North Fork
LAKE MC CLELLAN
Red Deer Creek
Sweetwater Cr
Graham Creek
Cantonment Cr
Cabin Creek
Grapevine Creek
Turkey
Red Mud Cr
Skillet Cr
Pond Cr

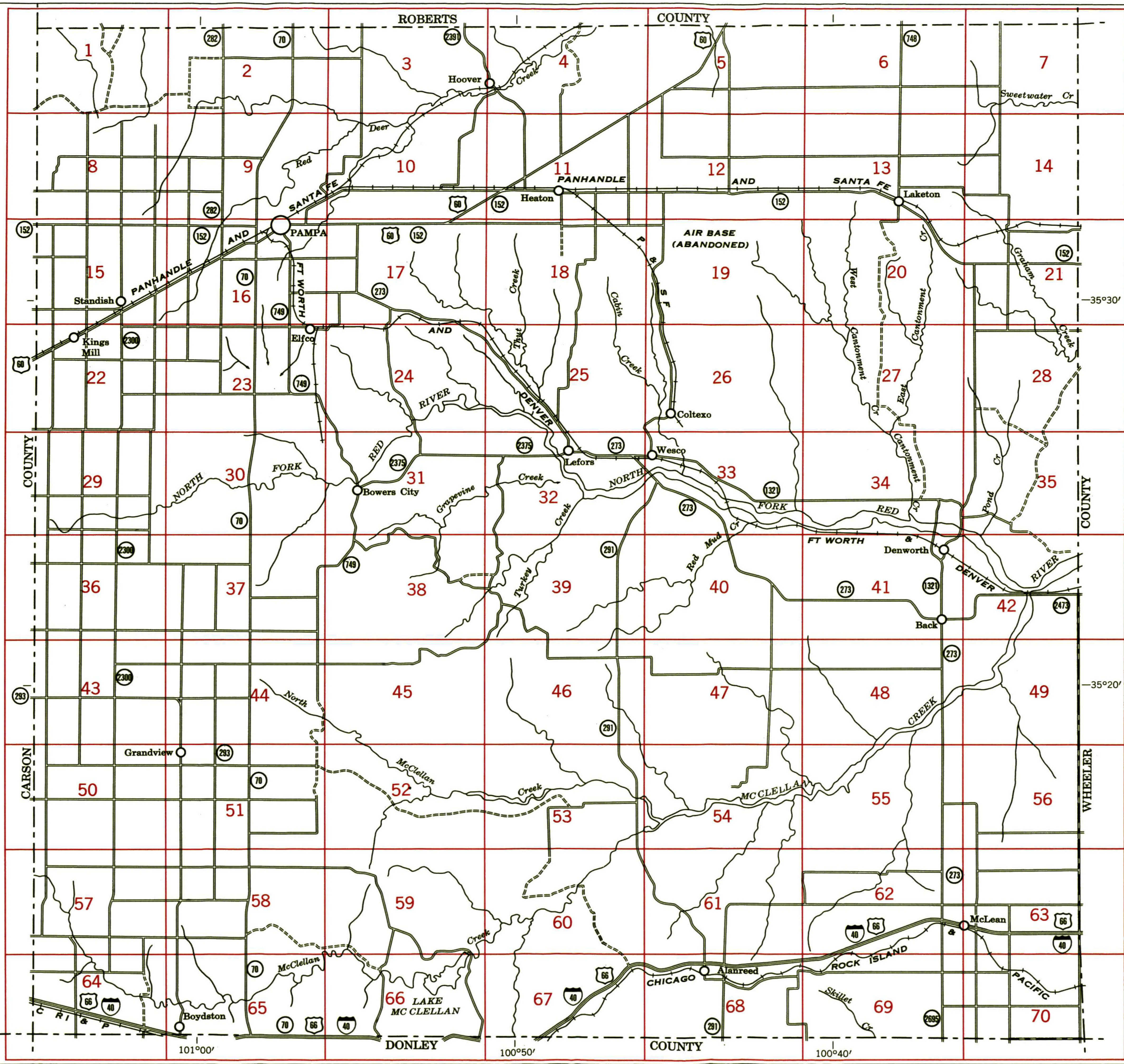
GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND RANGE SITES

[See table 2, p. 11, for the approximate acreage and proportionate extent of the soils, and table 3, p. 44, for the predicted average yields per acre of the principal crops. For information about the engineering properties of the soils, see the section beginning on p. 51]

Map symbol	Mapping unit	Described on page	Capability units				Range site	
			Dryland	Page	Irrigated	Page	Name	Page
Ba	Badland	11	VIIIe-2	40	(1/)	--	(2/)	--
BcB	Bippus clay loam, 1 to 3 percent slopes	13	IIIe-2	34	IIe-2	41	Deep Hardland	47
BfB	Bippus fine sandy loam, 1 to 3 percent slopes	13	IIIe-4	35	IIe-5	41	Sandy Loam	47
Hg	Hilly gravelly land	14	VIs-1	39	(1/)	--	Gravelly	48
LfD	Likes loamy fine sand, 3 to 8 percent slopes	14	VIe-6	38	(1/)	--	Sandyland	46
Ln	Lincoln soils	15	Vw-2	37	(1/)	--	Sandy Bottomland	46
MaB	Mansker clay loam, 1 to 3 percent slopes	16	IIIe-7	35	IIIe-7	42	Hardland Slopes	48
MaC	Mansker clay loam, 3 to 5 percent slopes	16	IVe-2	35	(1/)	--	Hardland Slopes	48
MaD	Mansker clay loam, 5 to 8 percent slopes	16	VIe-2	38	(1/)	--	Hardland Slopes	48
MbB	Mansker and Mobeetie fine sandy loams, 1 to 3 percent slopes	17	IVe-10	36	IIIe-7	42	Mixedland Slopes	47
McD	Mansker-Potter complex, 3 to 12 percent slopes	17						
	Mansker soil	--	VIe-2	38	(1/)	--	Hardland Slopes	48
	Potter soil	--	VIIs-1	39	(1/)	--	Very Shallow	48
MdB	Miles loamy fine sand, 0 to 3 percent slopes	19	IVe-6	36	IIIe-6	42	Sandyland	46
MdC	Miles loamy fine sand, 3 to 5 percent slopes	19	VIe-6	38	IVe-2	43	Sandyland	46
MfA	Miles fine sandy loam, 0 to 1 percent slopes	18	IIIe-4	35	IIe-4	41	Sandy Loam	47
MfB	Miles fine sandy loam, 1 to 3 percent slopes	18	IIIe-4	35	IIe-5	41	Sandy Loam	47
MfC	Miles fine sandy loam, 3 to 5 percent slopes	18	IVe-4	36	IIIe-3	42	Sandy Loam	47
MfC2	Miles fine sandy loam, 3 to 5 percent slopes, eroded	18	IVe-4	36	(1/)	--	Sandy Loam	47
MhC2	Miles and Brownfield soils, 3 to 5 percent slopes, eroded	19	VIe-6	38	(1/)	--	Sandyland	46
MoC	Mobeetie fine sandy loam, 3 to 8 percent slopes	20	VIe-3	38	(1/)	--	Mixedland Slopes	47
MxD	Mobeetie-Mansker-Potter complex, 3 to 12 percent slopes	20						
	Mobeetie soil	--	VIe-3	38	(1/)	--	Mixedland Slopes	47
	Mansker soil	--	VIe-3	38	(1/)	--	Mixedland Slopes	47
	Potter soil	--	VIIs-1	39	(1/)	--	Very Shallow	48
OcB	Olton clay loam, 1 to 3 percent slopes	21	IIIe-2	34	IIe-1	41	Deep Hardland	47
OcC	Olton clay loam, 3 to 5 percent slopes	21	IVe-1	35	(1/)	--	Deep Hardland	47
OmA	Olton loam, 0 to 1 percent slopes	21	IIce-5	32	I-2	40	Deep Hardland	47
OmB	Olton loam, 1 to 3 percent slopes	22	IIe-2	32	IIe-2	41	Deep Hardland	47
OmC	Olton loam, 3 to 5 percent slopes	22	IVe-1	35	(1/)	--	Deep Hardland	47
OzA	Olton and Zita clay loams, 0 to 1 percent slopes	22	IIIce-2	33	I-2	40	Deep Hardland	47
OzB	Olton and Zita clay loams, 1 to 3 percent slopes	22	IIIe-2	34	IIe-1	41	Deep Hardland	47
PcA	Portales clay loam, 0 to 1 percent slopes	23	IIIce-3	34	IIe-3	41	Deep Hardland	47
PcB	Portales clay loam, 1 to 3 percent slopes	23	IIIe-3	34	IIIe-4	42	Deep Hardland	47
PmE	Potter-Berthoud-Mansker complex, 5 to 20 percent slopes	24						
	Potter soil	--	VIIs-1	39	(1/)	--	Very Shallow	48
	Berthoud soils	--	VIe-2	38	(1/)	--	Hardland Slopes	48
	Mansker soil	--	VIe-2	38	(1/)	--	Hardland Slopes	48
PuA	Pullman clay loam, 0 to 1 percent slopes	24	IIIce-1	33	IIs-1	42	Deep Hardland	47
PuB	Pullman clay loam, 1 to 2 percent slopes	24	IIIe-1	34	IIIe-1	42	Deep Hardland	47
Ra	Randall clay	25	VIw-1	39	(1/)	--	(2/)	--
Rc	Roscoe clay	26	IIIe-1	34	IIs-1	42	Deep Hardland	47
Ro	Rough broken land	26	VIIs-2	40	(1/)	--	Rough Broken	49
Sa	Springer loamy fine sand, undulating	27	IVe-11	37	IVe-3	43	Sandyland	46
Sb	Springer loamy fine sand, hummocky	27	VIe-6	38	IVe-3	43	Sandyland	46
Sc	Spur clay loam	28	IIce-1	32	I-2	40	Loamy Bottomland	45
Sg	Spur and Guadalupe soils	28	IIIe-4	35	I-4	40	Loamy Bottomland	45
Sw	Sweetwater soils	29	Vw-3	37	(1/)	--	Loamy Bottomland	45
Tf	Tivoli fine sand	29	VIIe-1	39	(1/)	--	Deep Sand	46
Tm	Tivoli complex	29	VIe-6	38	(1/)	--	Sandyland	46
WcF	Woodward-Quinland complex, 5 to 50 percent slopes	30	VIe-2	38	(1/)	--	Mixedland	47

1/ Not placed in an irrigated capability unit.

2/ Badland not placed in a range site; Randall clay included in the surrounding range site.



INDEX TO MAP SHEETS
GRAY COUNTY, TEXAS

Scale 1:190,080

1 0 1 2 3 4 Miles

SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, E, or F, shows the slope. Most symbols without a slope letter are for nearly level soils such as Randall clay, but some are for soils that have a considerable range in slope, such as Woodward–Quinlan complex. A final number, 2, in the symbol means that a soil is eroded. (W) following the soil name indicates that signs of erosion, especially of local shifting of soil by wind, are evident in places, but the degree of erosion cannot be estimated reliably.

SYMBOL	NAME
Ba	Badland
BcB	Bippus clay loam, 1 to 3 percent slopes
BfB	Bippus fine sandy loam, 1 to 3 percent slopes
Hg	Hilly gravelly land
LfD	Likes loamy fine sand, 3 to 8 percent slopes (W)
Ln	Lincoln soils (W)
MaB	Mansker clay loam, 1 to 3 percent slopes
MaC	Mansker clay loam, 3 to 5 percent slopes
MaD	Mansker clay loam, 5 to 8 percent slopes
MbB	Mansker and Mobeetie fine sandy loams, 1 to 3 percent slopes
McD	Mansker–Potter complex, 3 to 12 percent slopes (W)
MdB	Miles loamy fine sand, 0 to 3 percent slopes
MdC	Miles loamy fine sand, 3 to 5 percent slopes (W)
MfA	Miles fine sandy loam, 0 to 1 percent slopes
MfB	Miles fine sandy loam, 1 to 3 percent slopes
MfC	Miles fine sandy loam, 3 to 5 percent slopes
MfC2	Miles fine sandy loam, 3 to 5 percent slopes, eroded
MhC2	Miles and Brownfield soils, 3 to 5 percent slopes, eroded
MoC	Mobeetie fine sandy loam, 3 to 8 percent slopes
MxD	Mobeetie–Mansker–Potter complex, 3 to 12 percent slopes (W)
OcB	Olton clay loam, 1 to 3 percent slopes
OcC	Olton clay loam, 3 to 5 percent slopes
OmA	Olton loam, 0 to 1 percent slopes
OmB	Olton loam, 1 to 3 percent slopes
OmC	Olton loam, 3 to 5 percent slopes
OzA	Olton and Zita clay loams, 0 to 1 percent slopes
OzB	Olton and Zita clay loams, 1 to 3 percent slopes
PcA	Portales clay loam, 0 to 1 percent slopes
PcB	Portales clay loam, 1 to 3 percent slopes
PmE	Potter–Berthoud–Mansker complex, 5 to 20 percent slopes
PuA	Pullman clay loam, 0 to 1 percent slopes
PuB	Pullman clay loam, 1 to 2 percent slopes
Ra	Randall clay
Rc	Roscoe clay
Ro	Rough broken land
Sa	Springer loamy fine sand, undulating (W)
Sb	Springer loamy fine sand, hummocky (W)
Sc	Spur clay loam
Sg	Spur and Guadalupe soils
Sw	Sweetwater soils
Tf	Tivoli fine sand (W)
Tm	Tivoli complex (W)
WcF	Woodward–Quinlan complex, 5 to 50 percent slopes (W)

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferries
- Ford
- Grade
- R. R. over
- R. R. under
- Tunnel

Buildings
- School
- Church
- Station

Mines and Quarries
- Mine dump
- Pits, caliche or other

Power lines

Pipe lines

Cemeteries

Dams

Levees

Tanks

Oil wells

BOUNDARIES

- National or state
- County
- Land corners
- Reservation
- Land grant

DRAINAGE

Streams
- Perennial
- Intermittent, unclass.

Canals and ditches — CANAL, DITCH

Lakes and ponds
- Perennial
- Intermittent

Well, irrigation — I.W.

Springs

Marsh

Wet spot

Alluvial fan

Drainage end

RELIEF

Escarpments
- Bedrock
- Other

Prominent peaks

Depressions (Large, Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

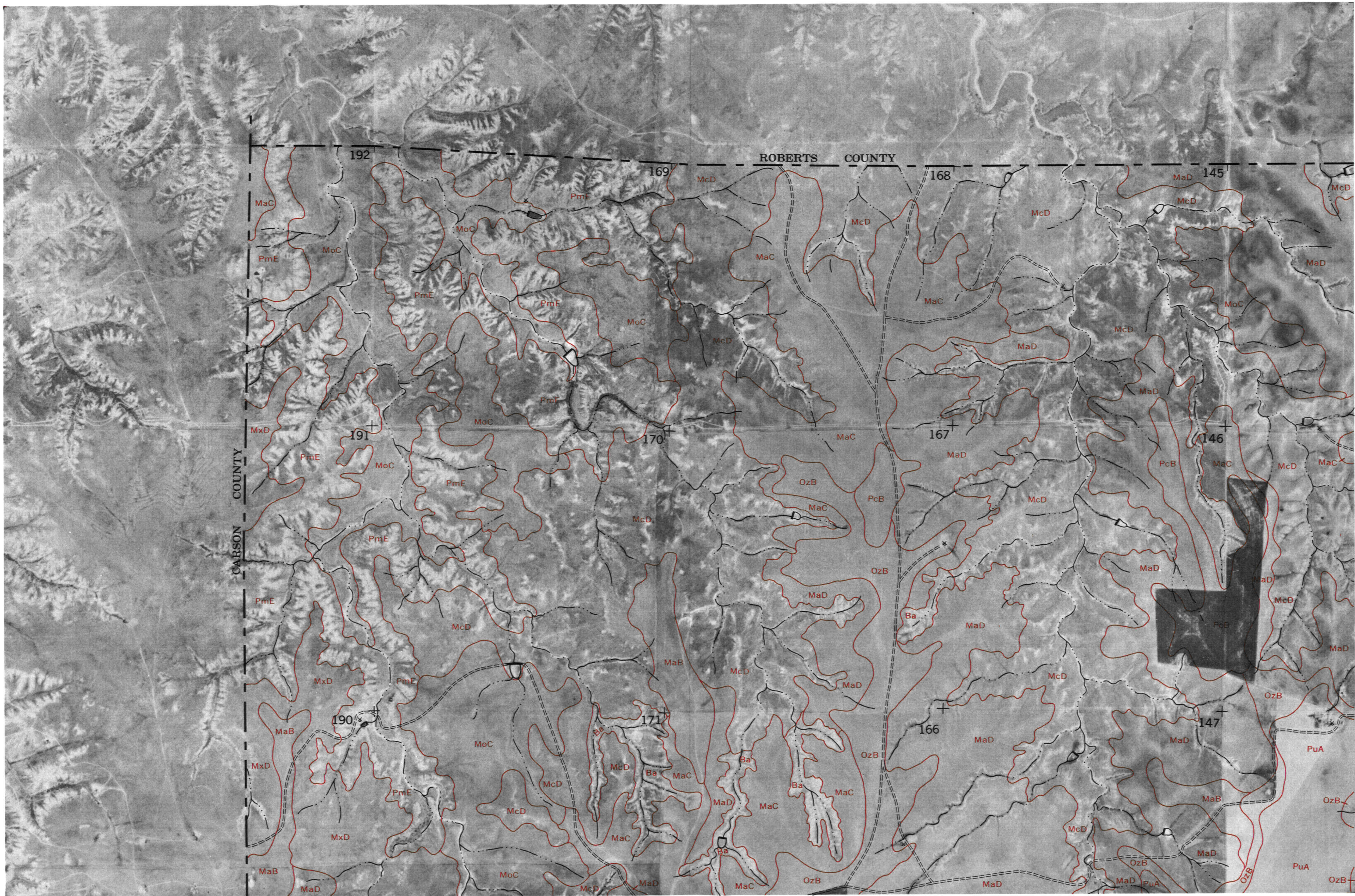
- Soil boundary and symbol — Dx
- Gravel
- Stones
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gullies

Soil map constructed 1965 by Cartographic Division, Soil Conservation Service, USDA, from 1959 aerial photographs. Controlled mosaic based on Texas plane coordinate system, north zone, Lambert conformal conic projection, 1927 North American datum.

1

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.



(Joins sheet 2)

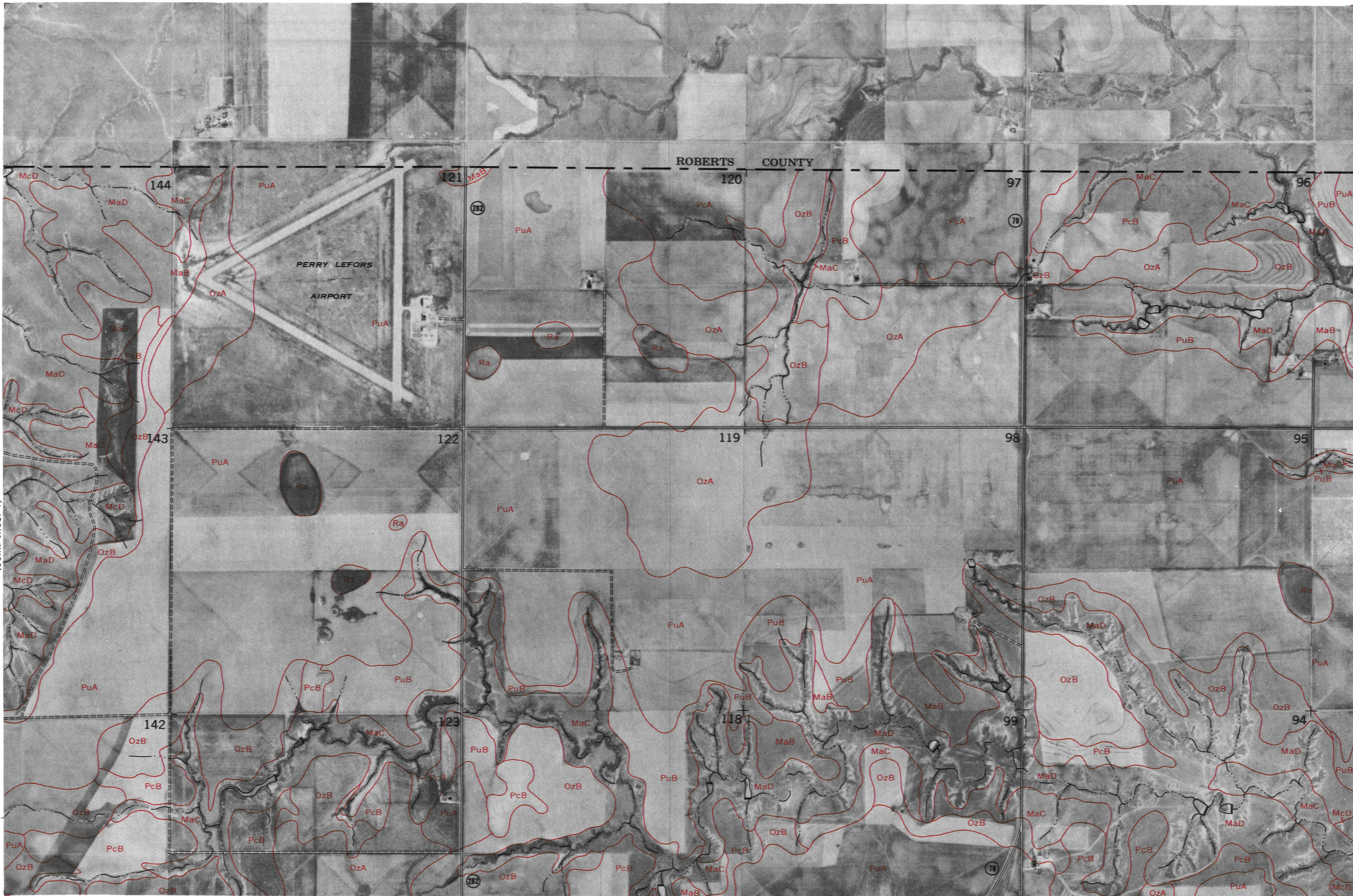
(Joins sheet 8)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

GRAY COUNTY, TEXAS — SHEET NUMBER 2

2

N



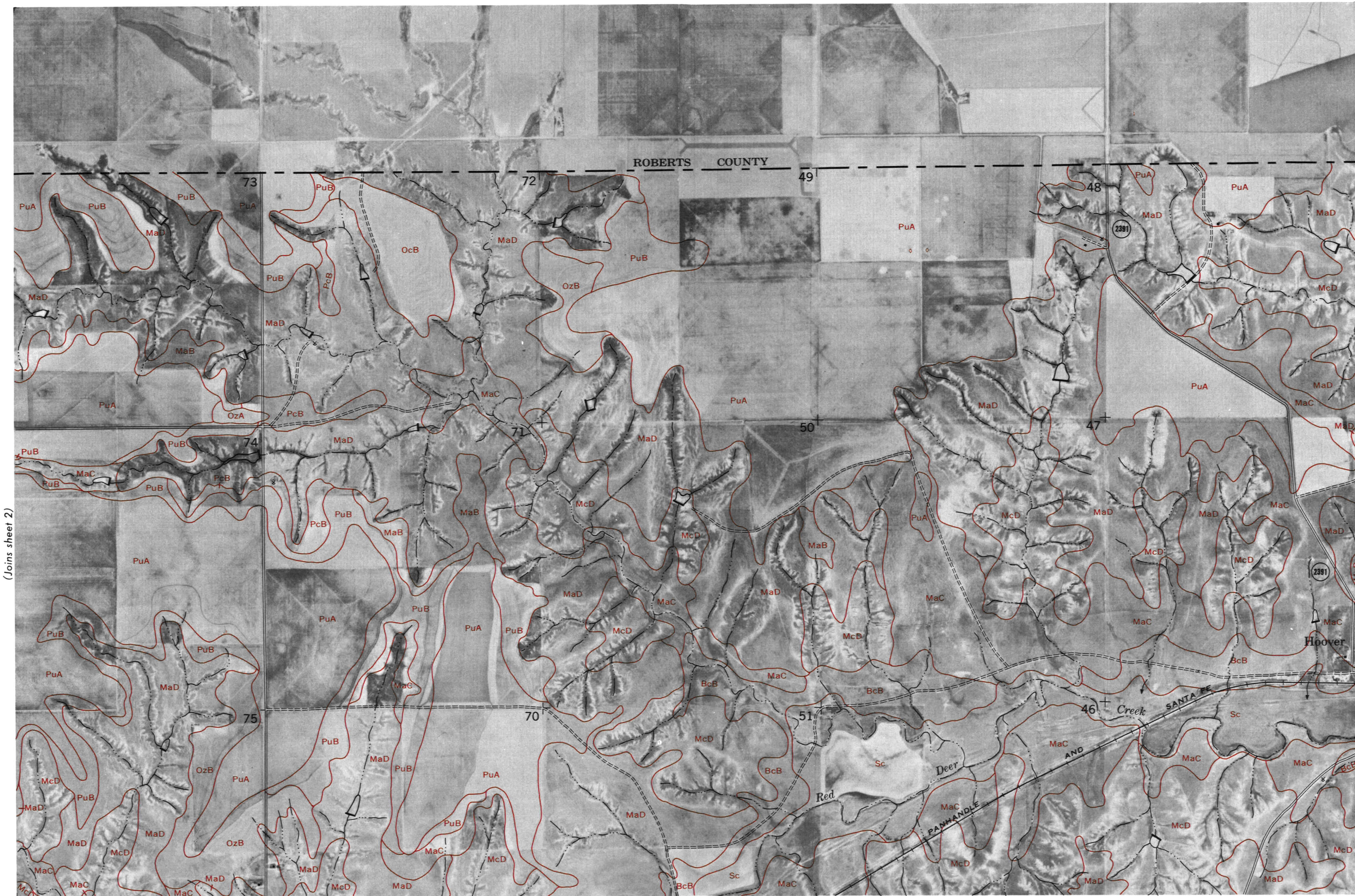
(Joins sheet 1)

(Joins sheet 3)

(Joins sheet 9)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

3



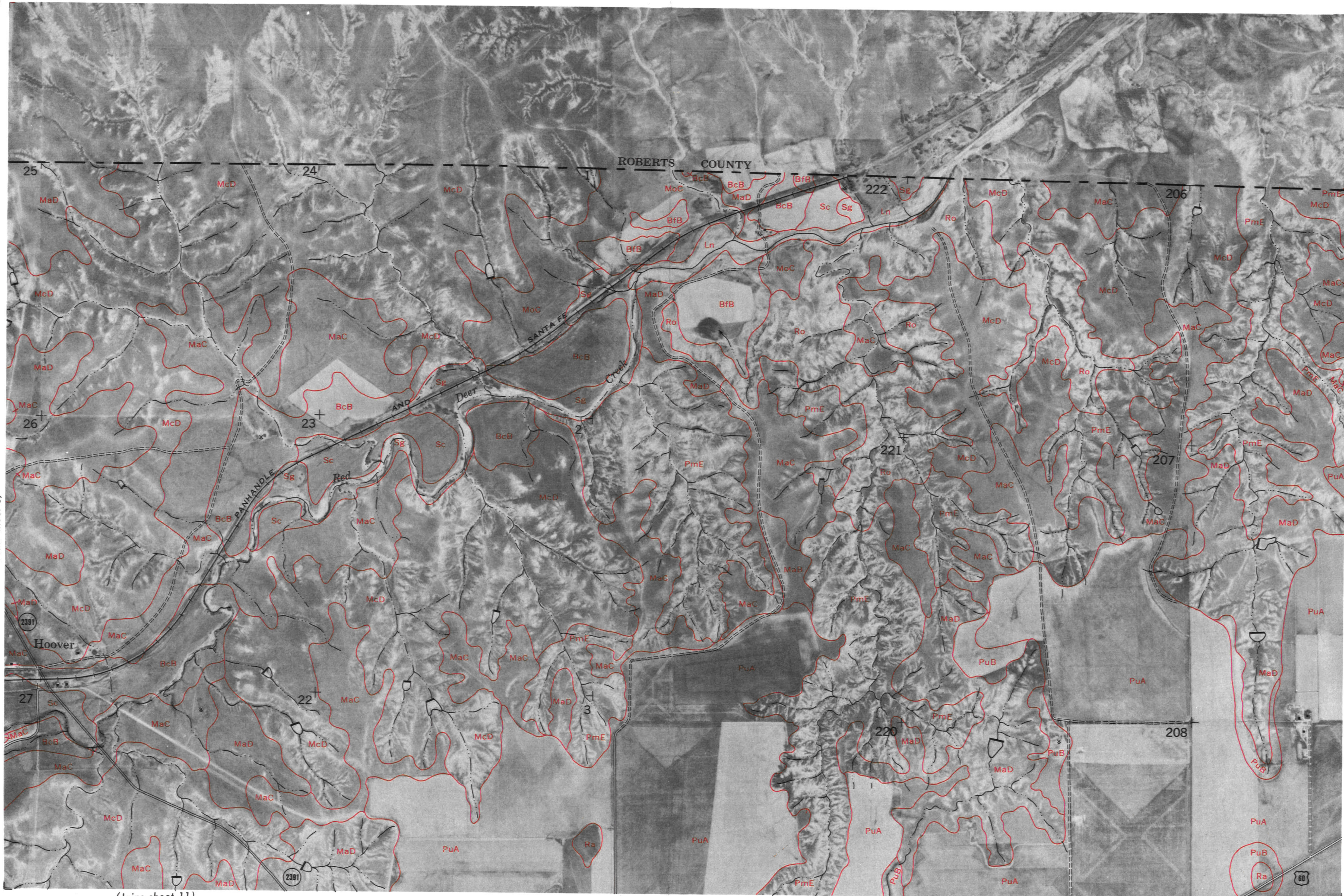
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

GRAY COUNTY, TEXAS — SHEET NUMBER 4

N



(Joins sheet 3)

(Joins sheet 5)

(Joins sheet 11)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

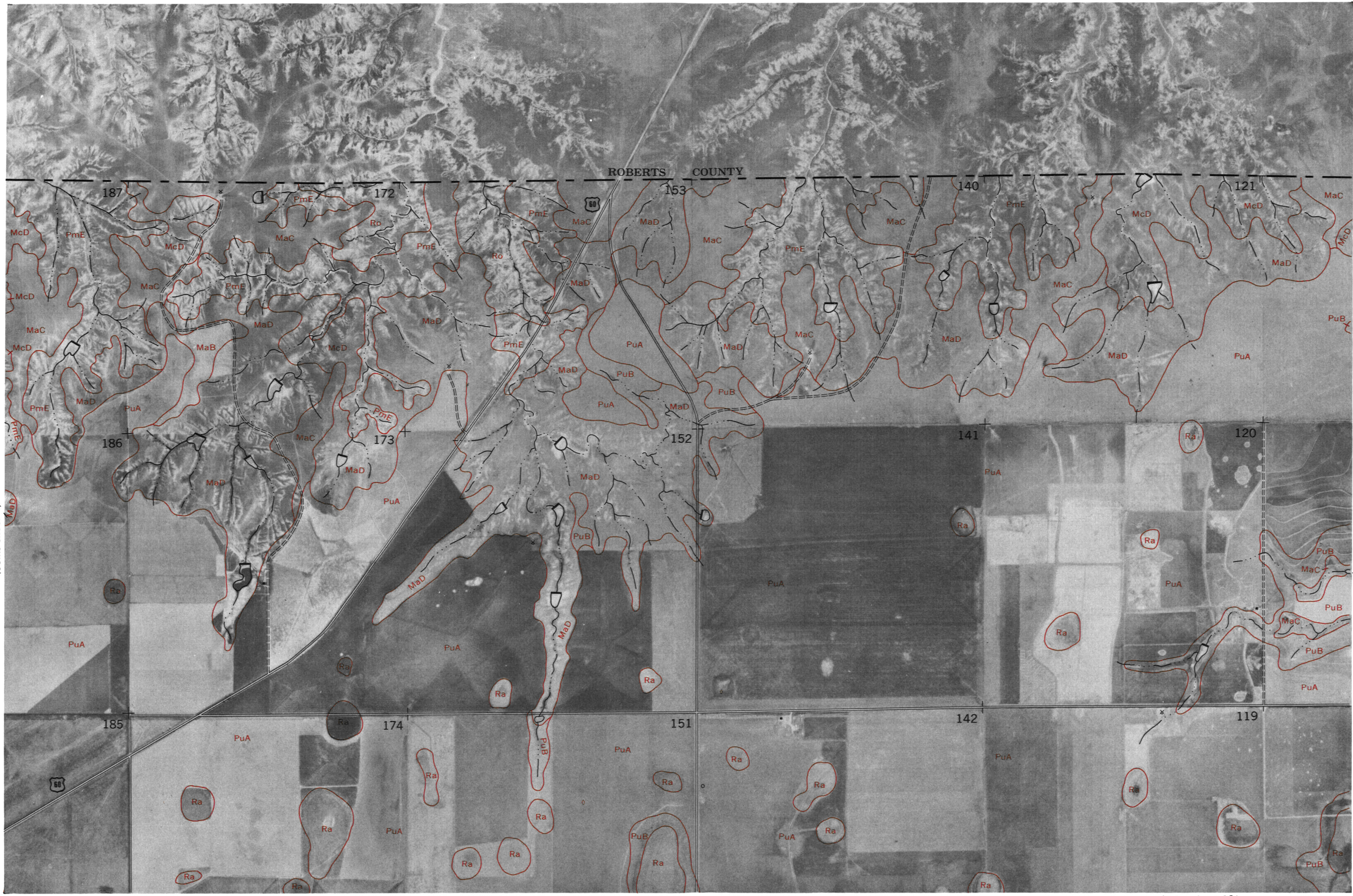
5

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

N

(Joins sheet 4)



(Joins sheet 6)

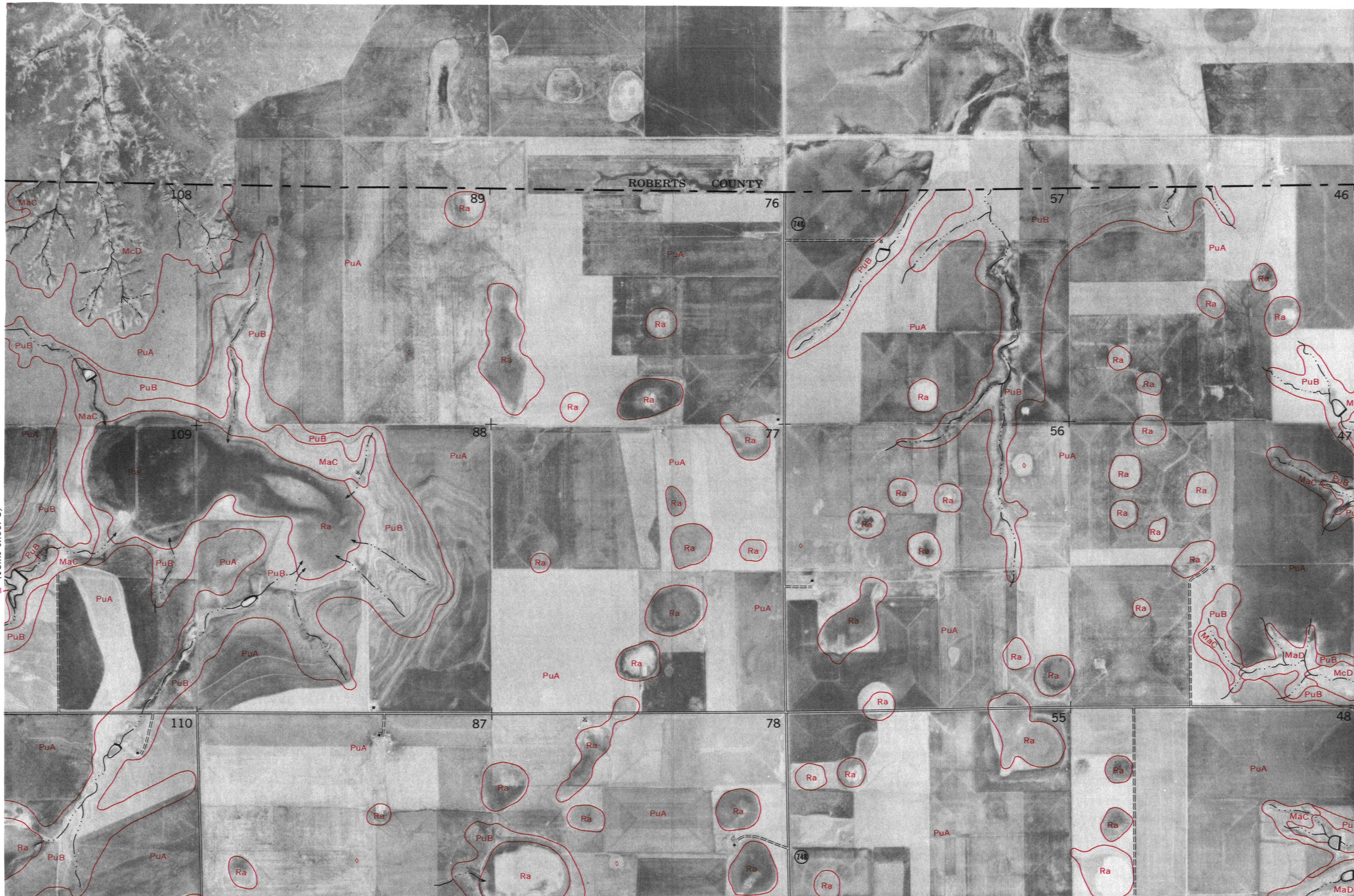
(Joins sheet 12)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

6

N

(Joins sheet 5)

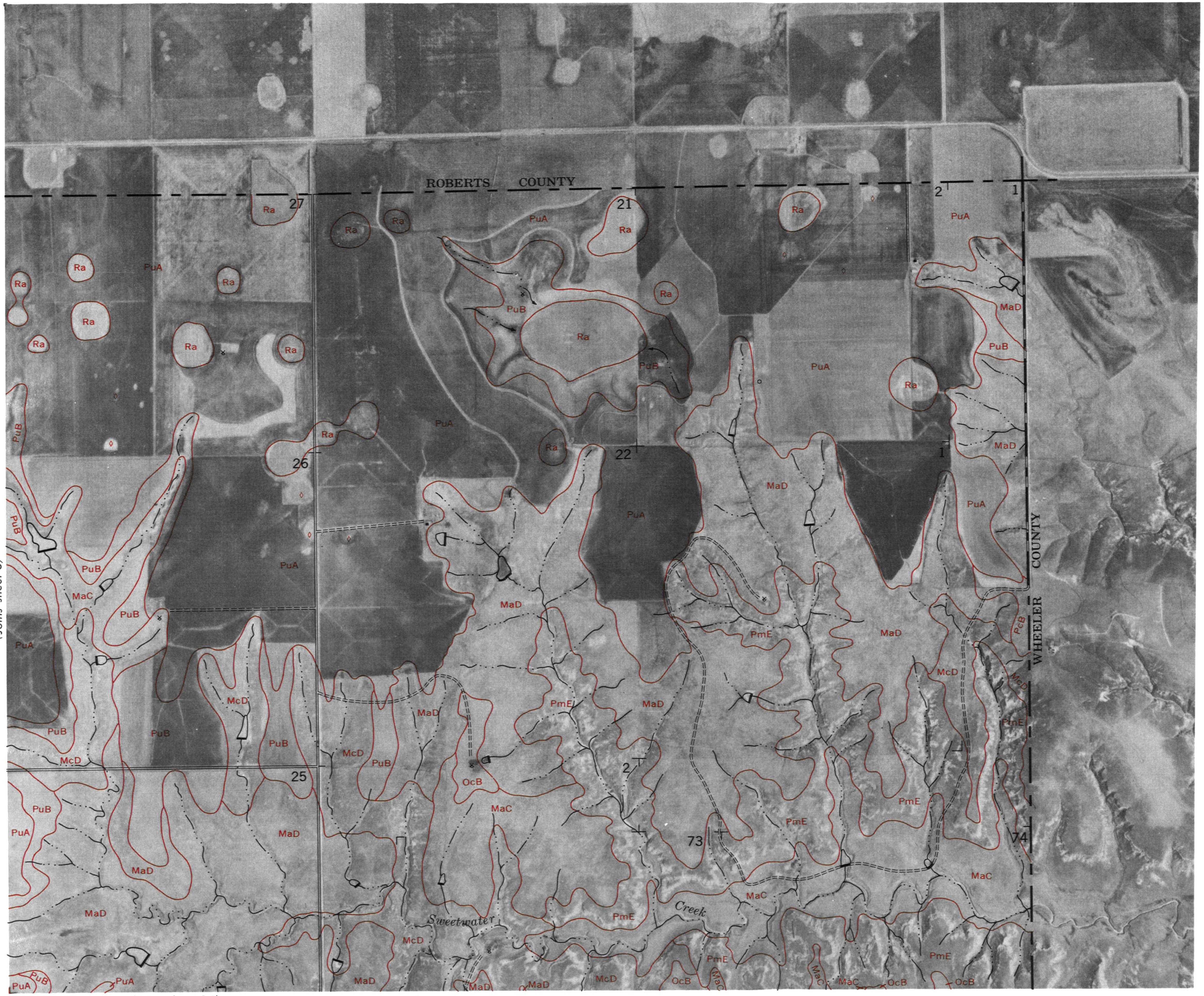


(Joins sheet 7)

(Joins sheet 13)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

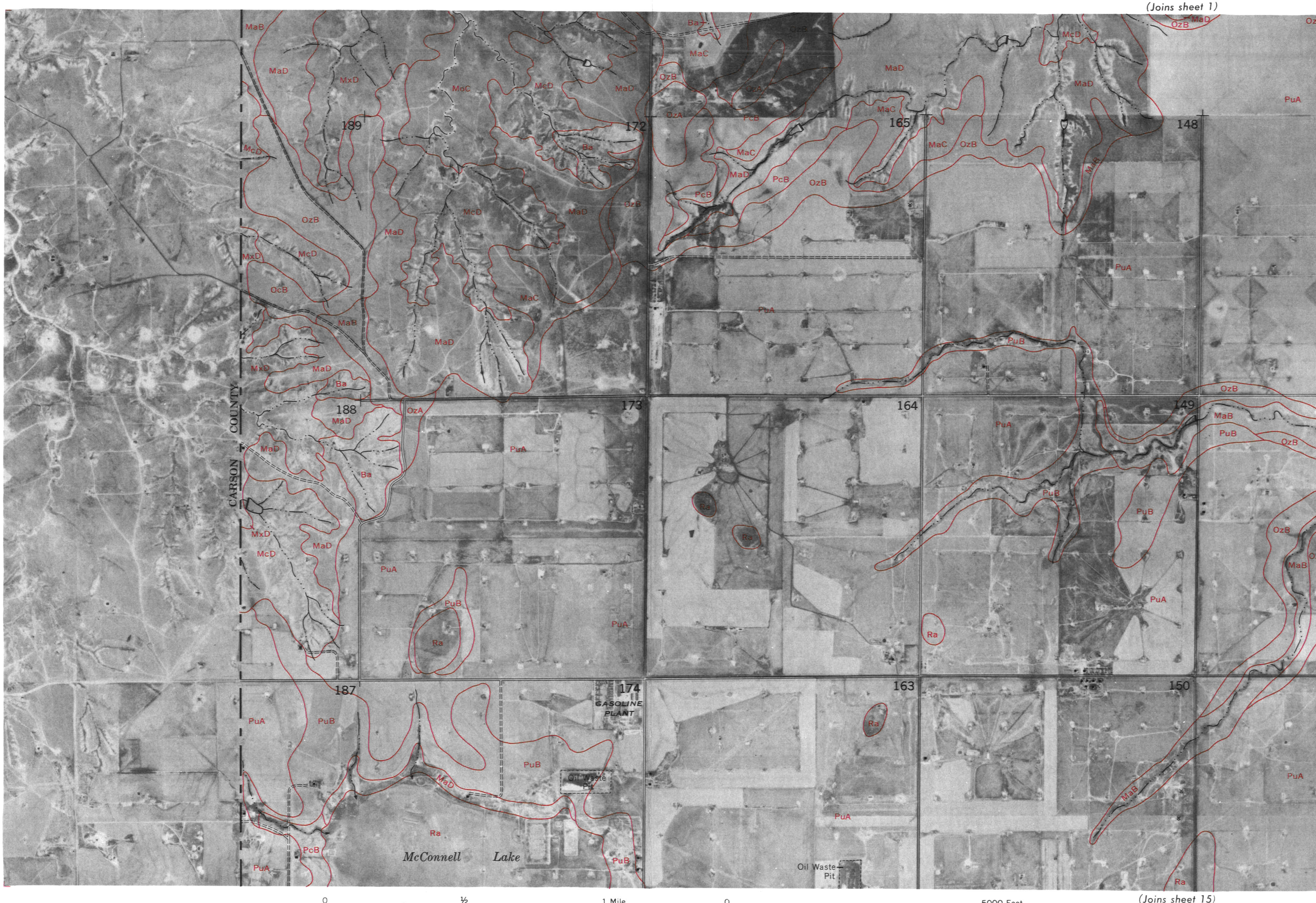
7



This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station

Land division corners and numbers shown on this map are indefinite.

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet


N
(Joins sheet 1)
(Joins sheet 9)
(Joins sheet 15)
CARSON COUNTY
189
172
165
148
188
173
164
149
187
174
163
150
GASOLINE PLANT
Oil Waste Pit
Oil Waste Pit
McConnell Lake
MaB
MaD
MxD
McC
McD
MaC
OzB
OzA
Ba
PcB
PuA
PuB
OcB
Ra
0 ½ 1 Mile
Scale 1: 20 000
0 5000 Feet

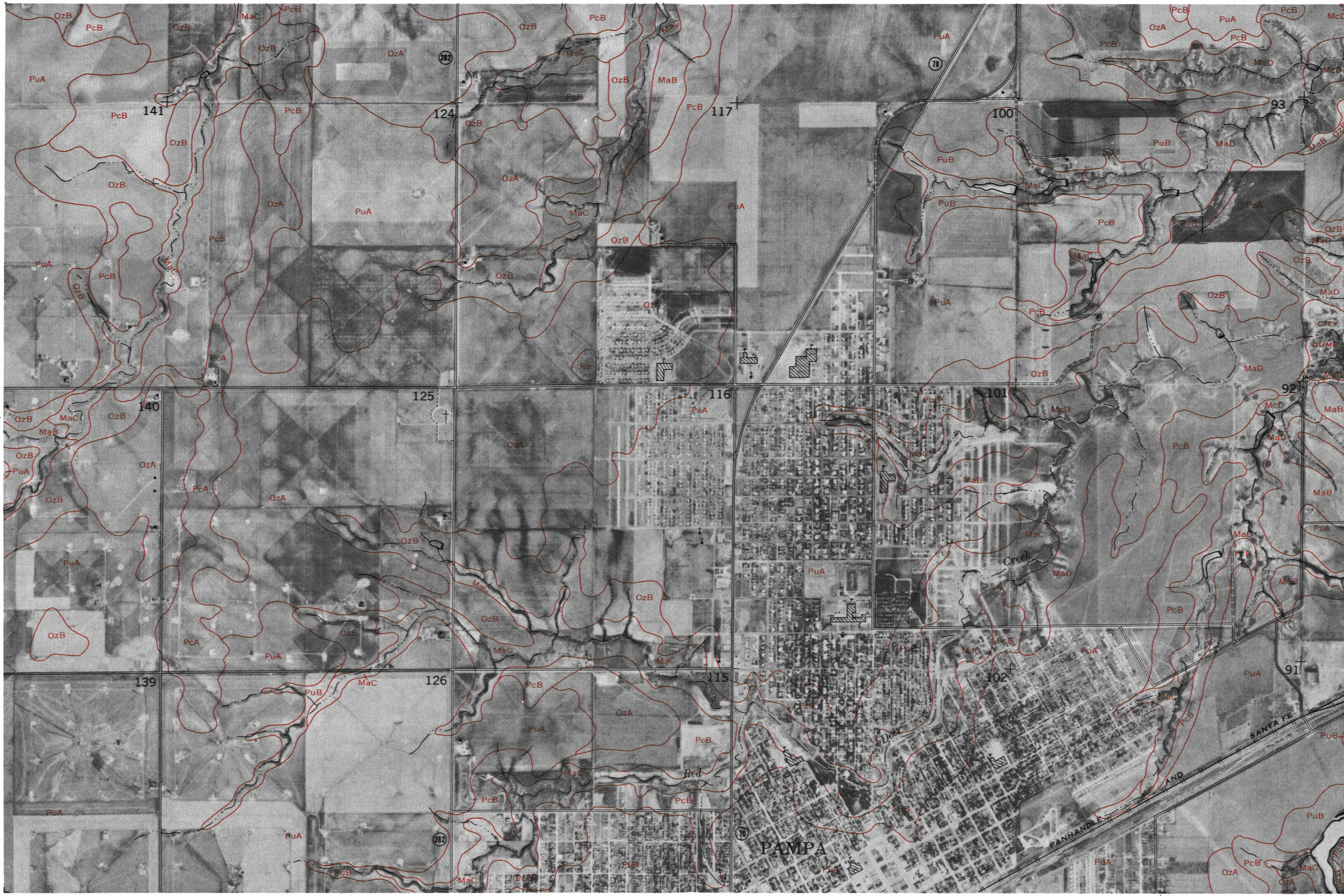
(Joins sheet 2) 9

N

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

(Joins sheet 8)



(Joins sheet 10)

(Joins sheet 16)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

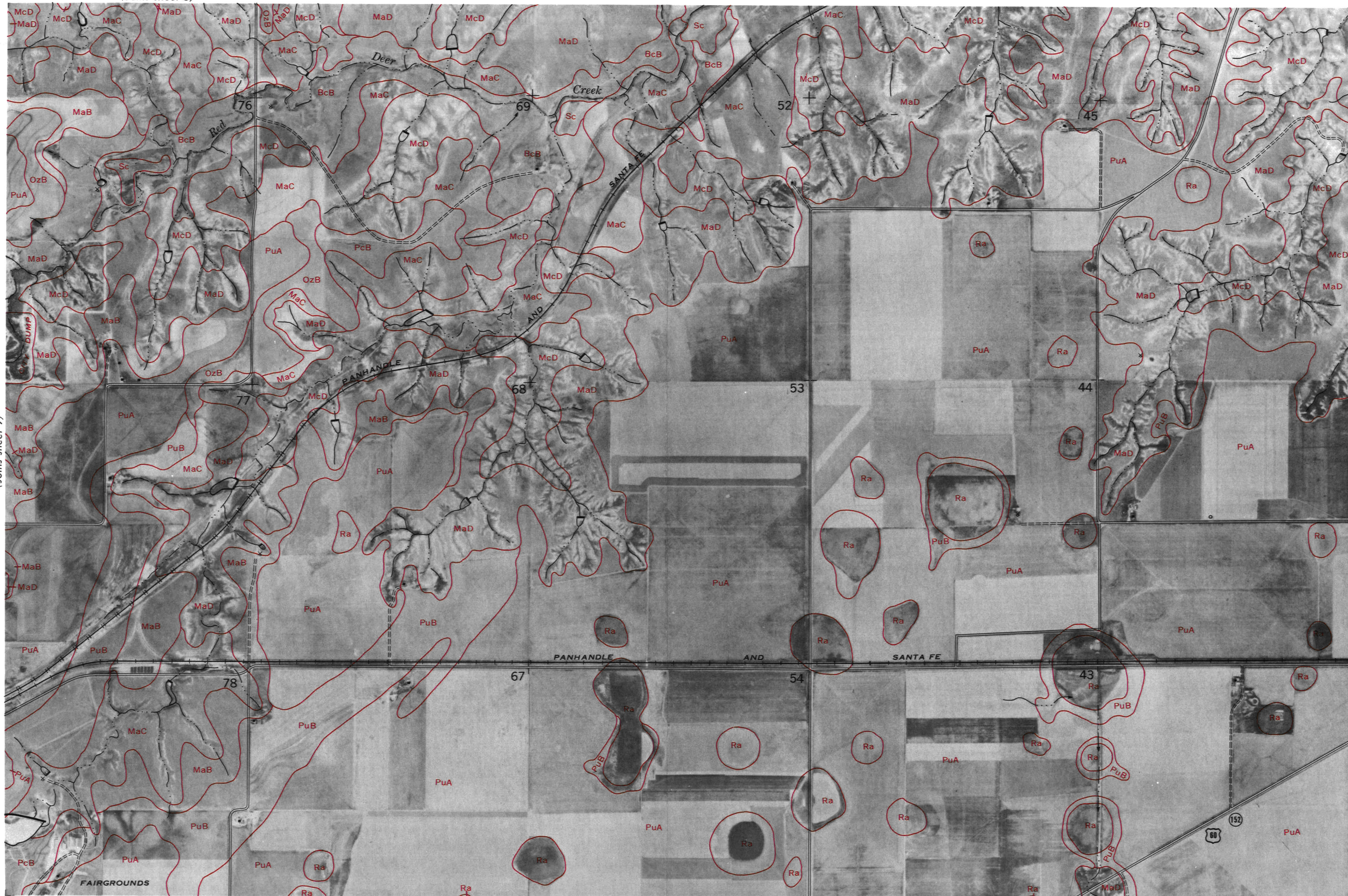
(10)

GRAY COUNTY, TEXAS — SHEET NUMBER 10

(Joins sheet 3)

N

(Joins sheet 9)



(Joins sheet 11)

(Joins sheet 17)

0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

(Joins sheet 4)

11

(Joins sheet 10)

(Joins sheet 12)

(Joins sheet 18)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

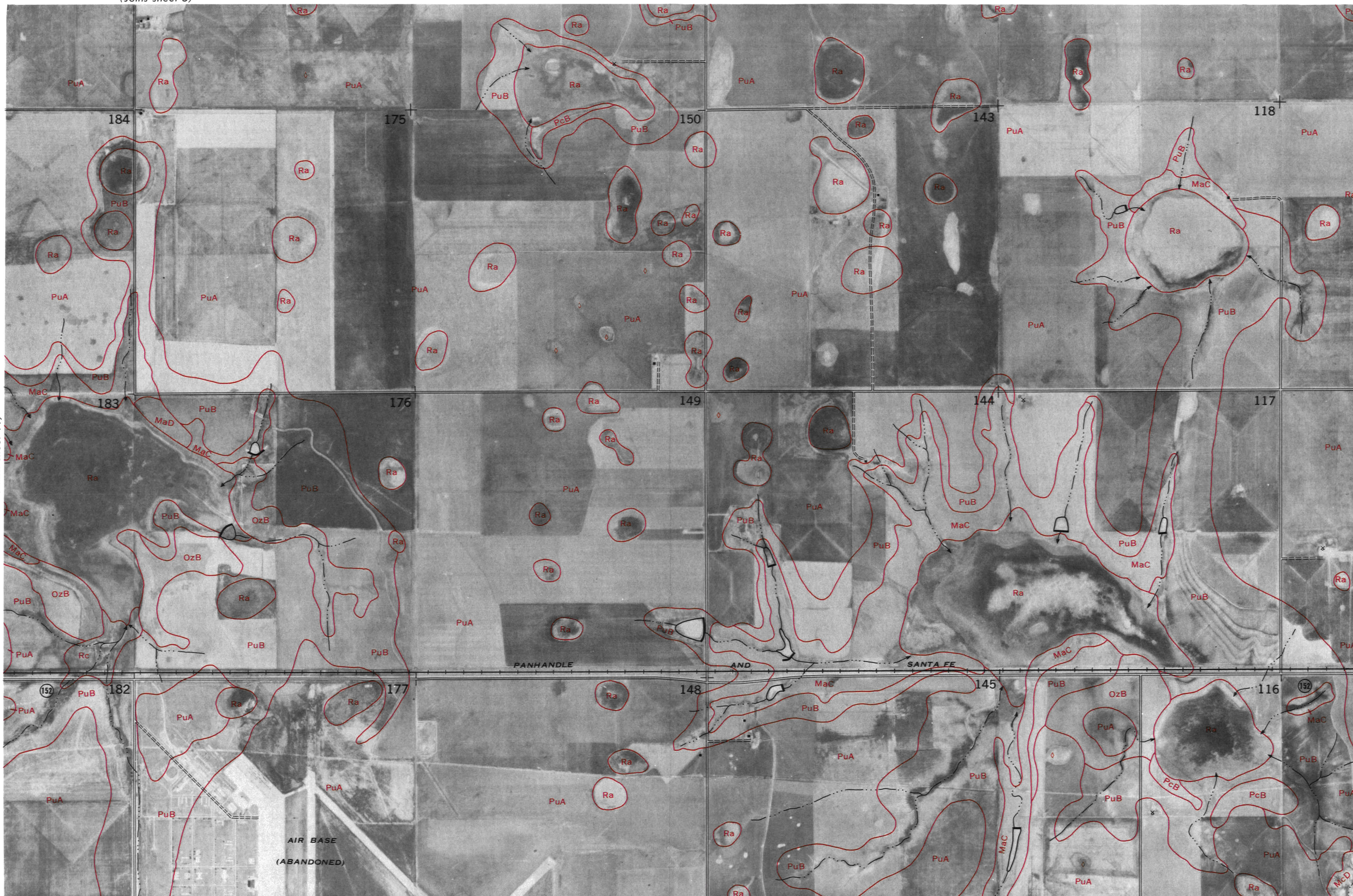
12

GRAY COUNTY, TEXAS — SHEET NUMBER 12

(Joins sheet 5)

N

(Joins sheet 11)



(Joins sheet 13)

(Joins sheet 19)

0 ½ 1 Mile

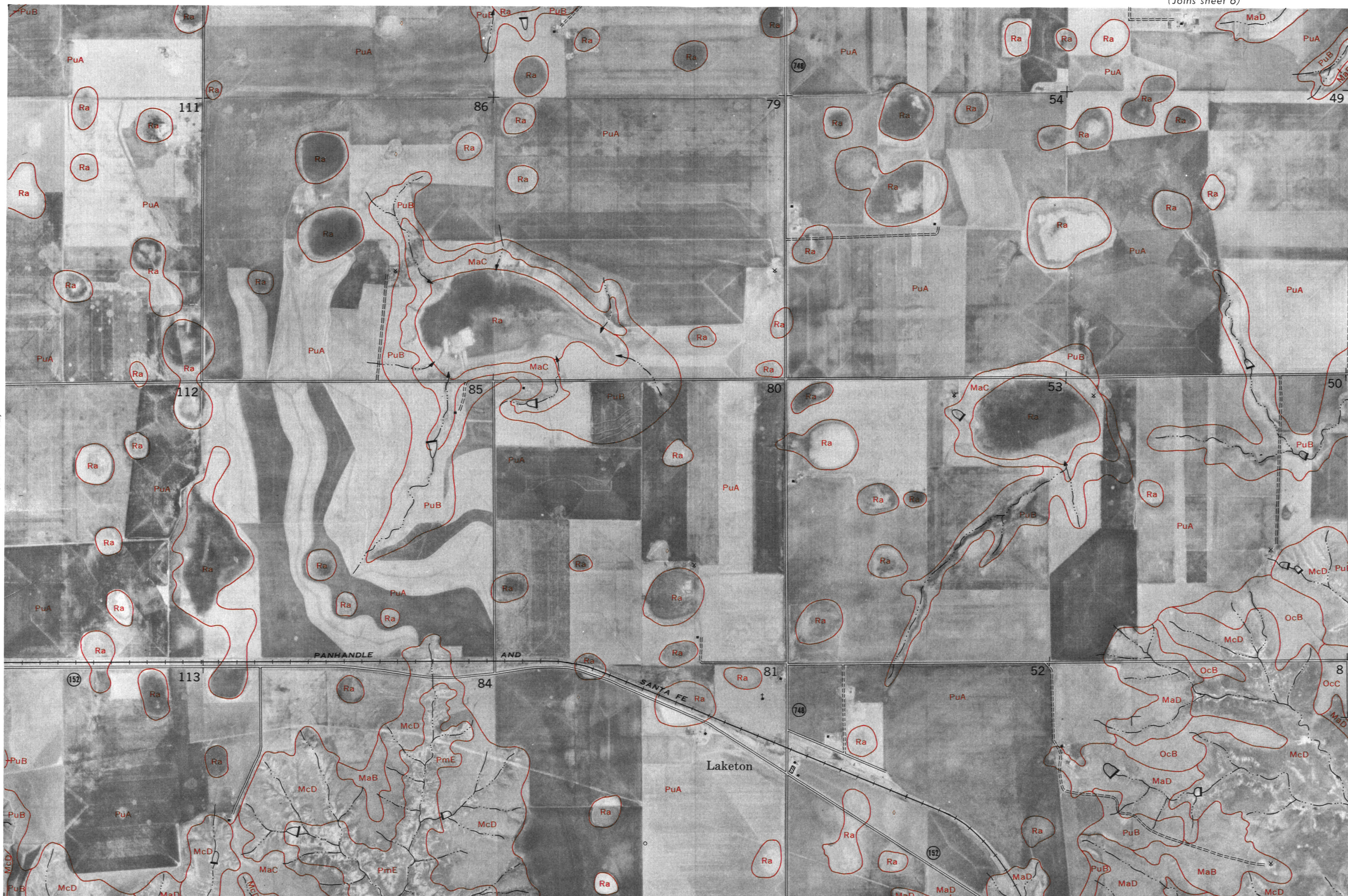
Scale 1: 20 000

0 5000 Feet

13

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.



0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

GRAY COUNTY, TEXAS — SHEET NUMBER 14

(Joins sheet 7)

N

(Joins sheet 13)

(Joins sheet 21)

0 ½ 1 Mile

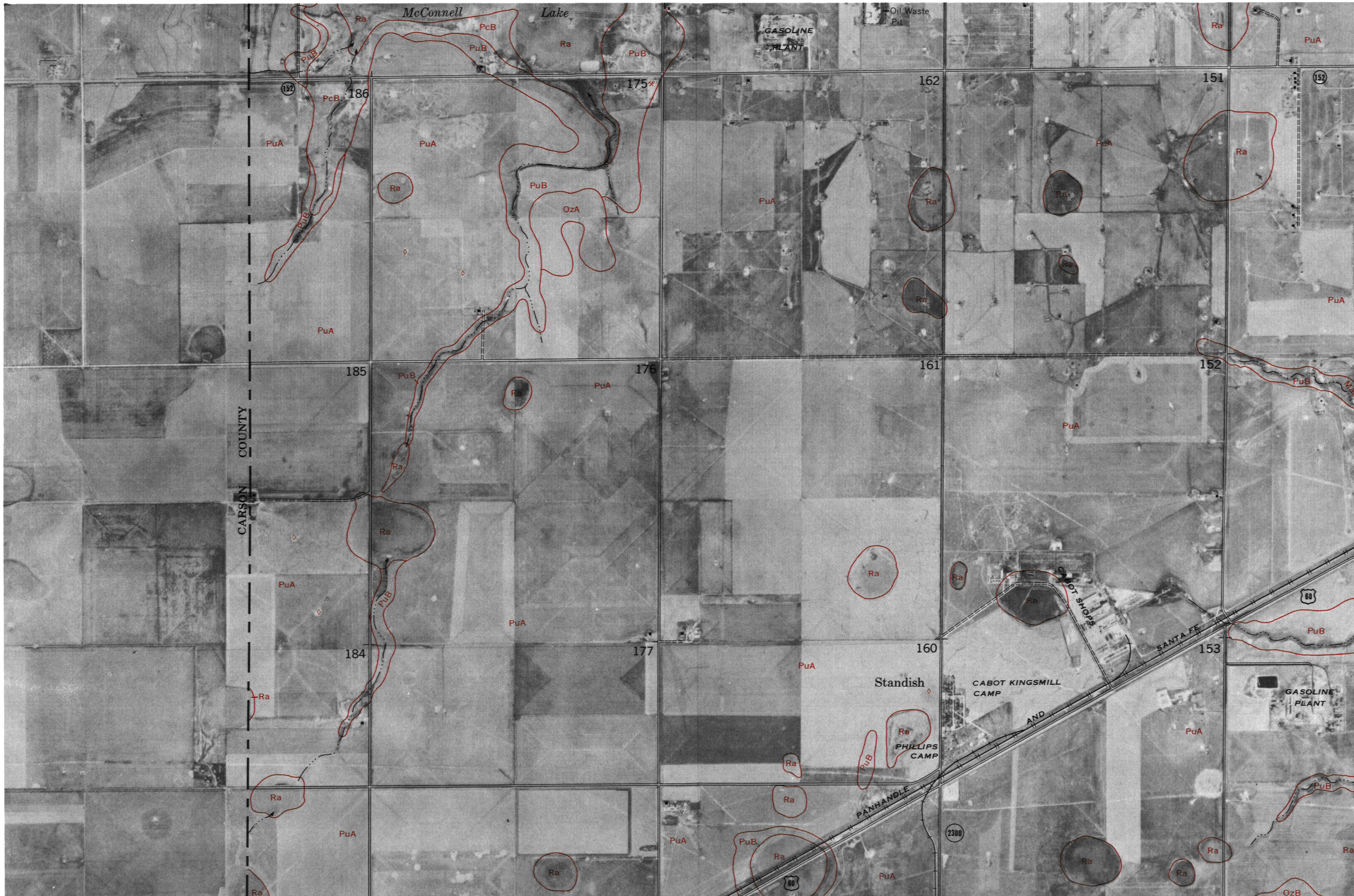
Scale 1: 20 000

0 5000 Feet

(15)

(Joins sheet 8)

N



(Joins sheet 16)

(Joins sheet 22)

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

0 ½ 1 Mile

Scale 1: 20 000

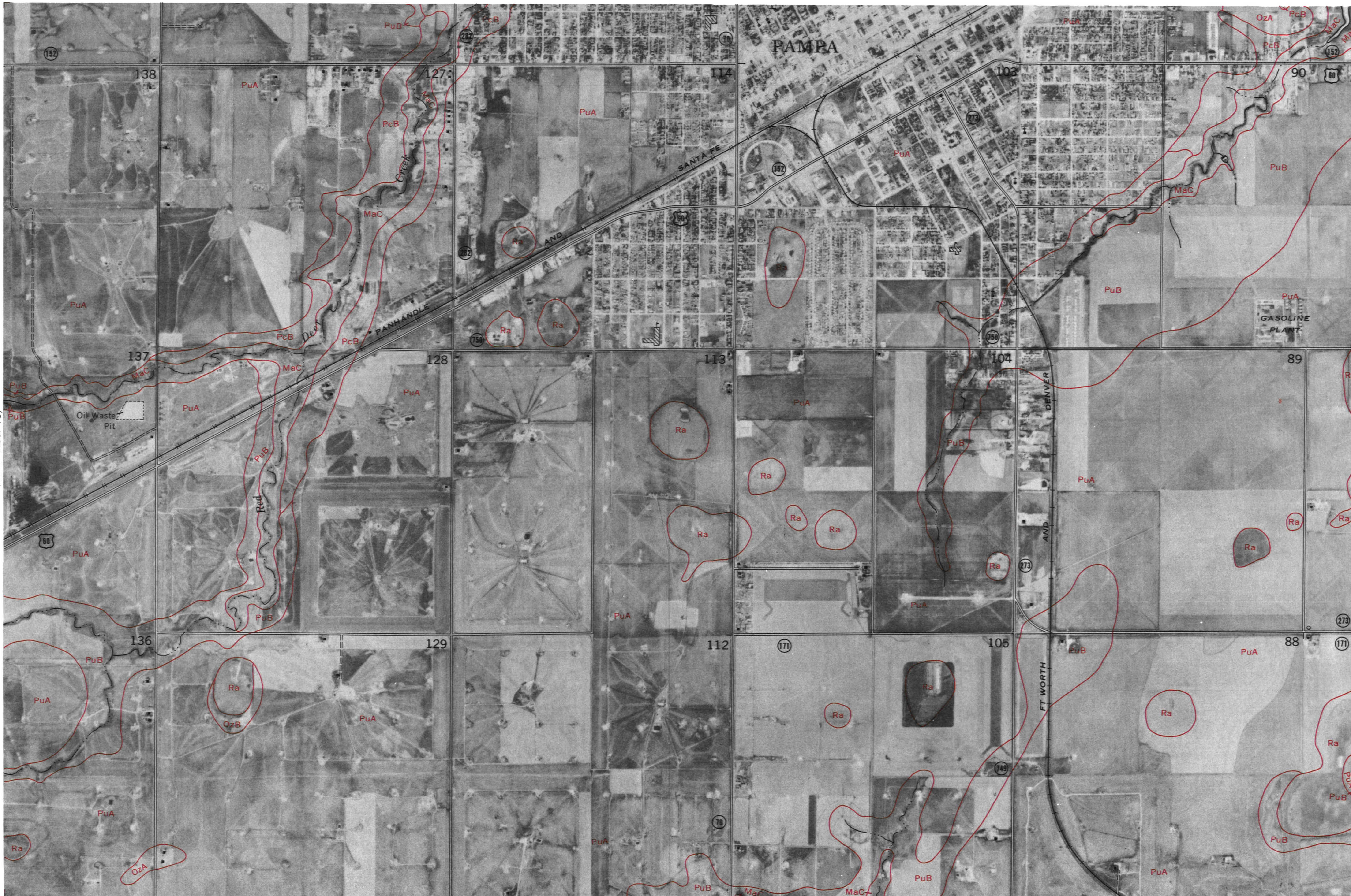
0 5000 Feet

(16)

GRAY COUNTY, TEXAS — SHEET NUMBER 16

(Joins sheet 9)

N



(Joins sheet 15)

(Joins sheet 17)

(Joins sheet 23)

0 ½ 1 Mile

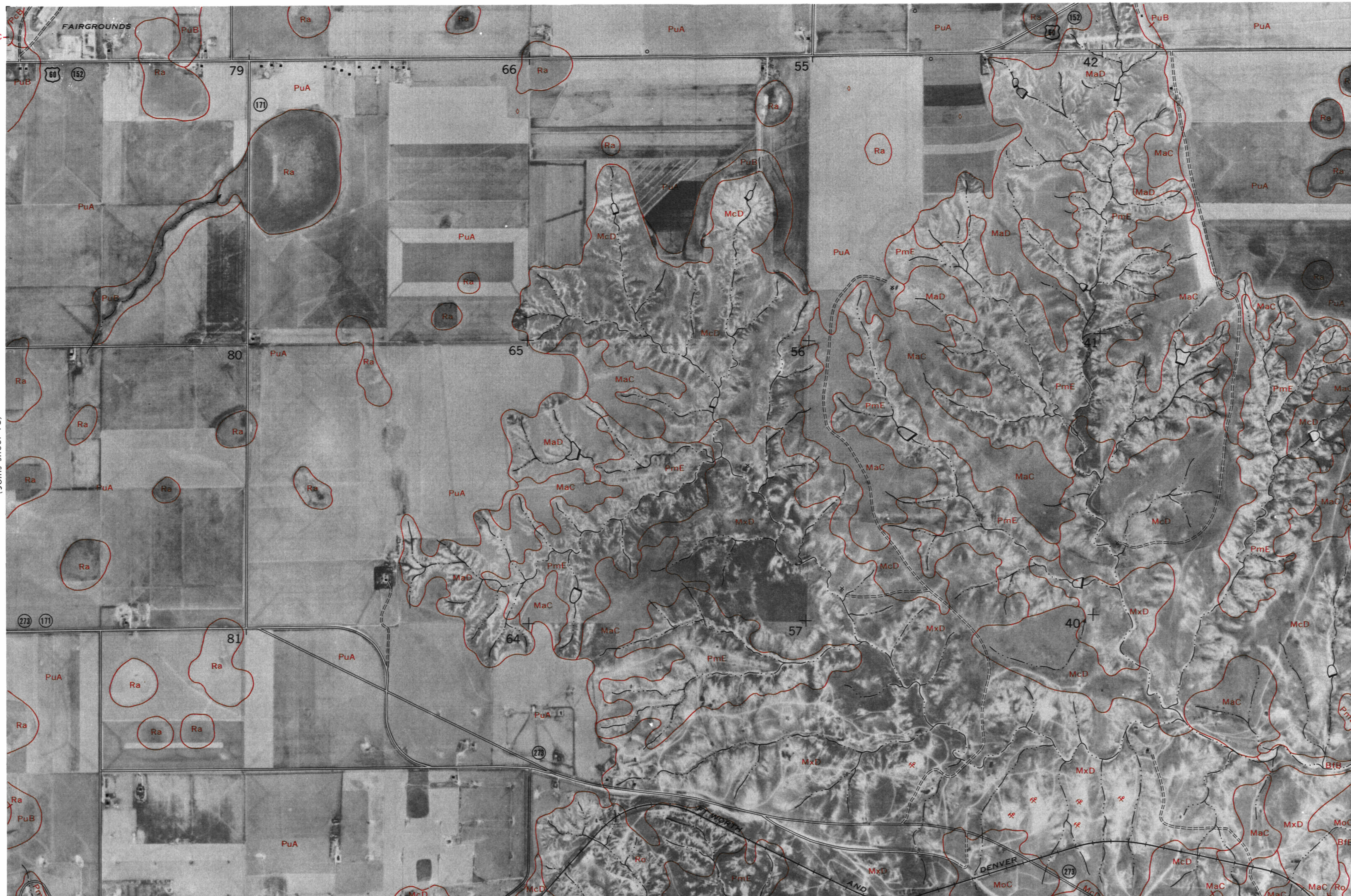
Scale 1: 20 000

0 5000 Feet

(Joins sheet 10)

17

N



(Joins sheet 16)

(Joins sheet 18)

(Joins sheet 24)

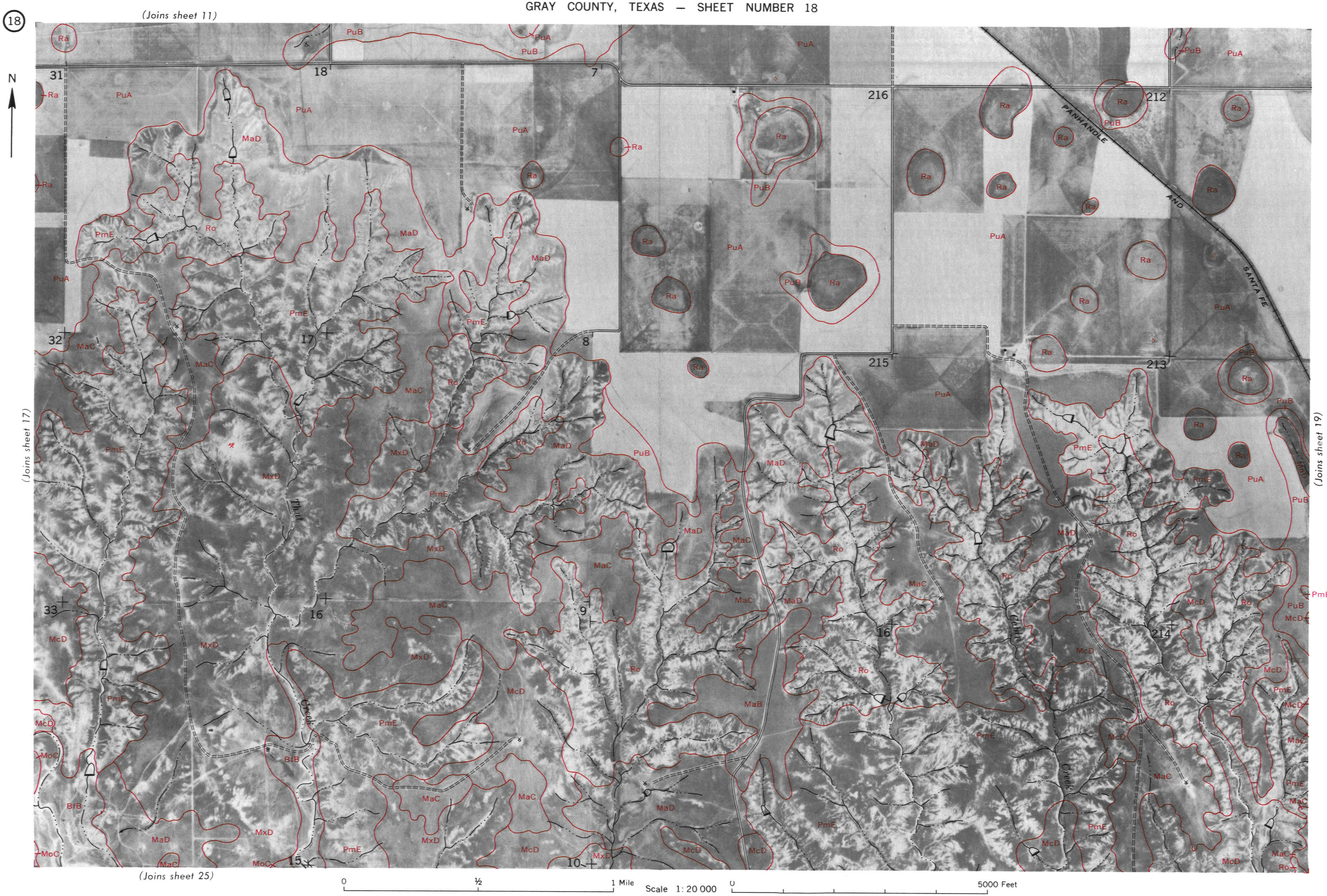
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

18

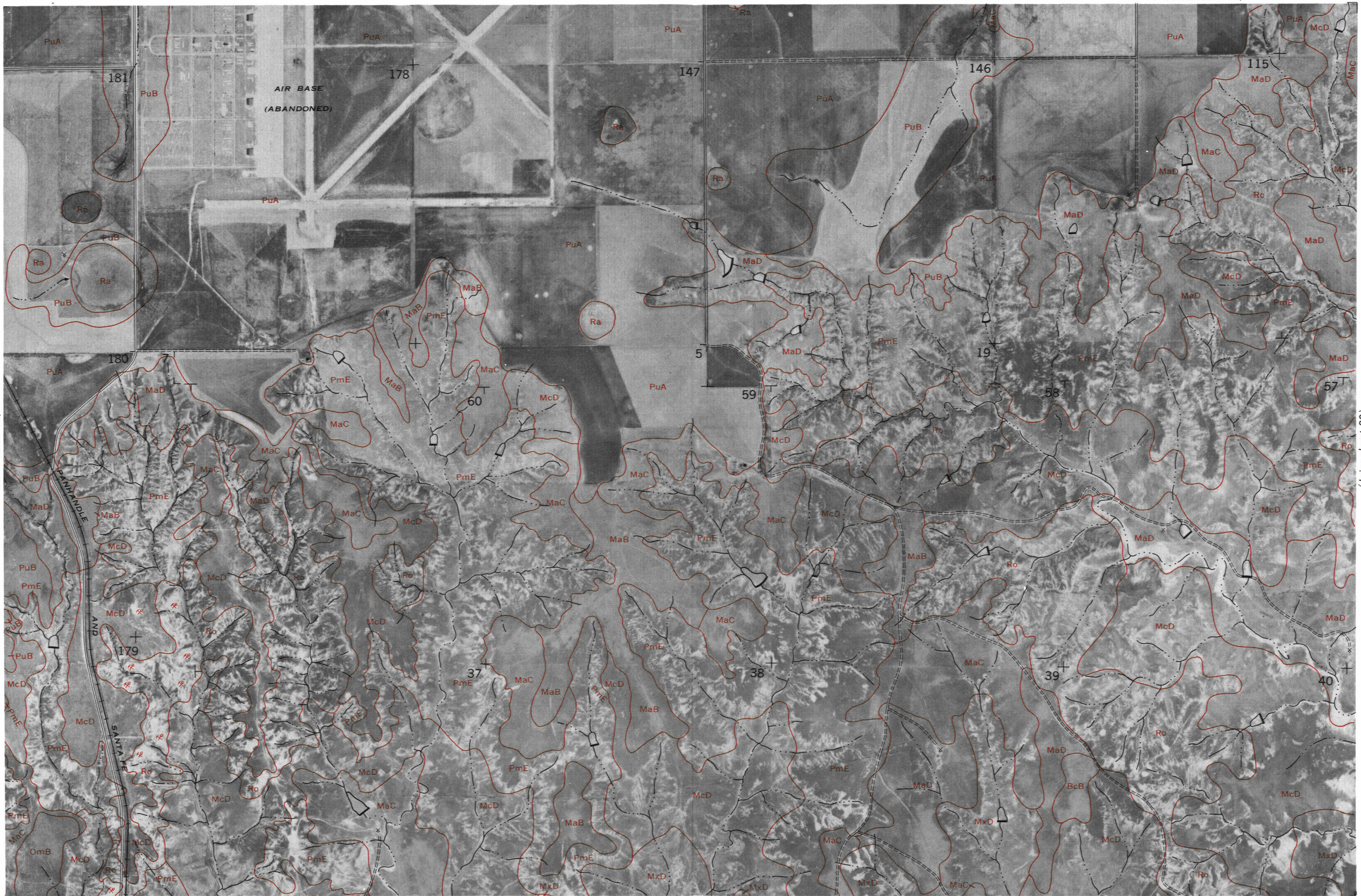
GRAY COUNTY, TEXAS — SHEET NUMBER 18



(Joins sheet 12)

19

(Joins sheet 18)



(Joins sheet 20)

(Joins sheet 26)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

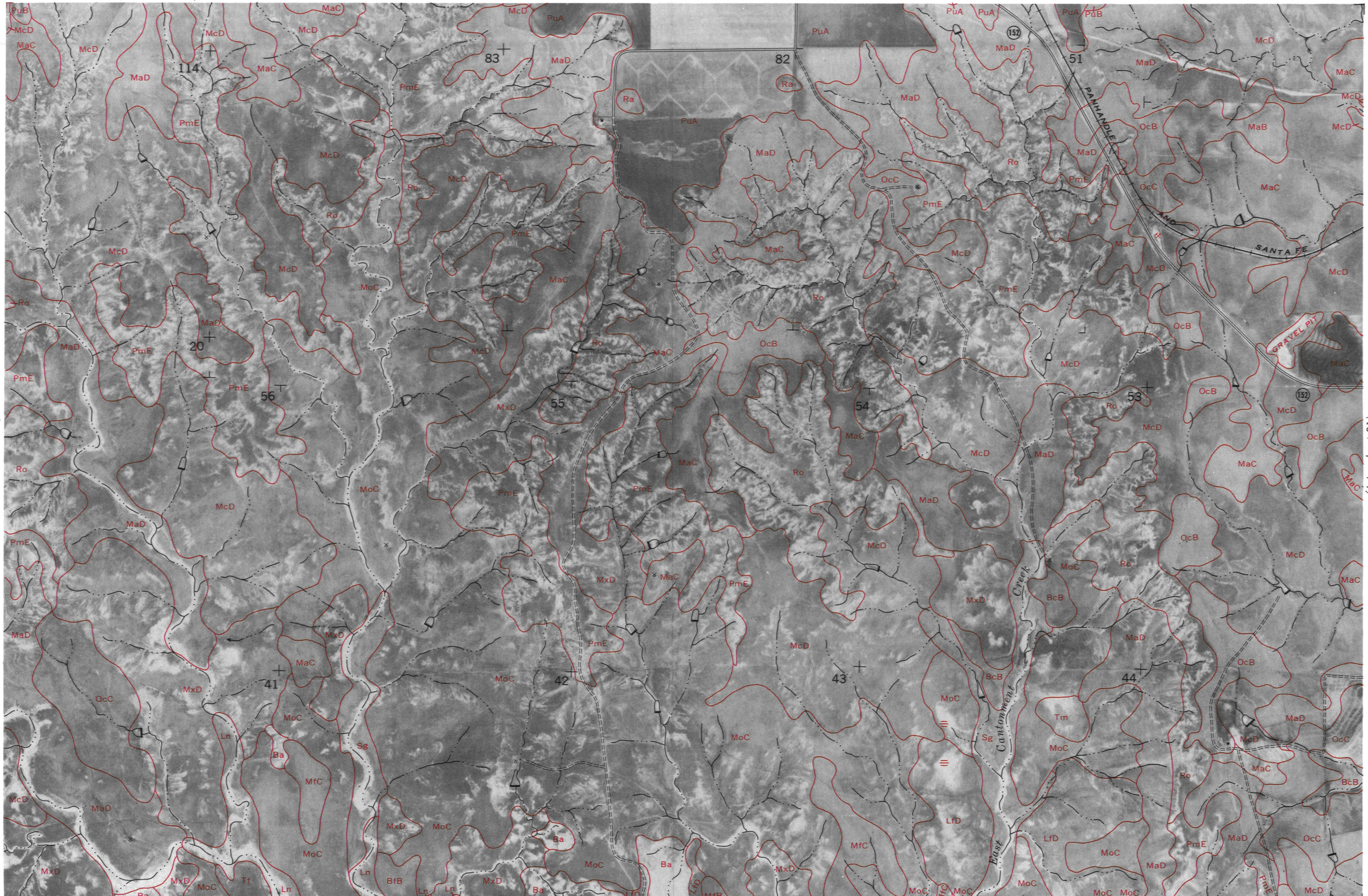
20

GRAY COUNTY, TEXAS — SHEET NUMBER 20

(Joins sheet 13)

N

(Joins sheet 19)



(Joins sheet 21)

(Joins sheet 27)

0 ½ 1 Mile

Scale 1:20 000

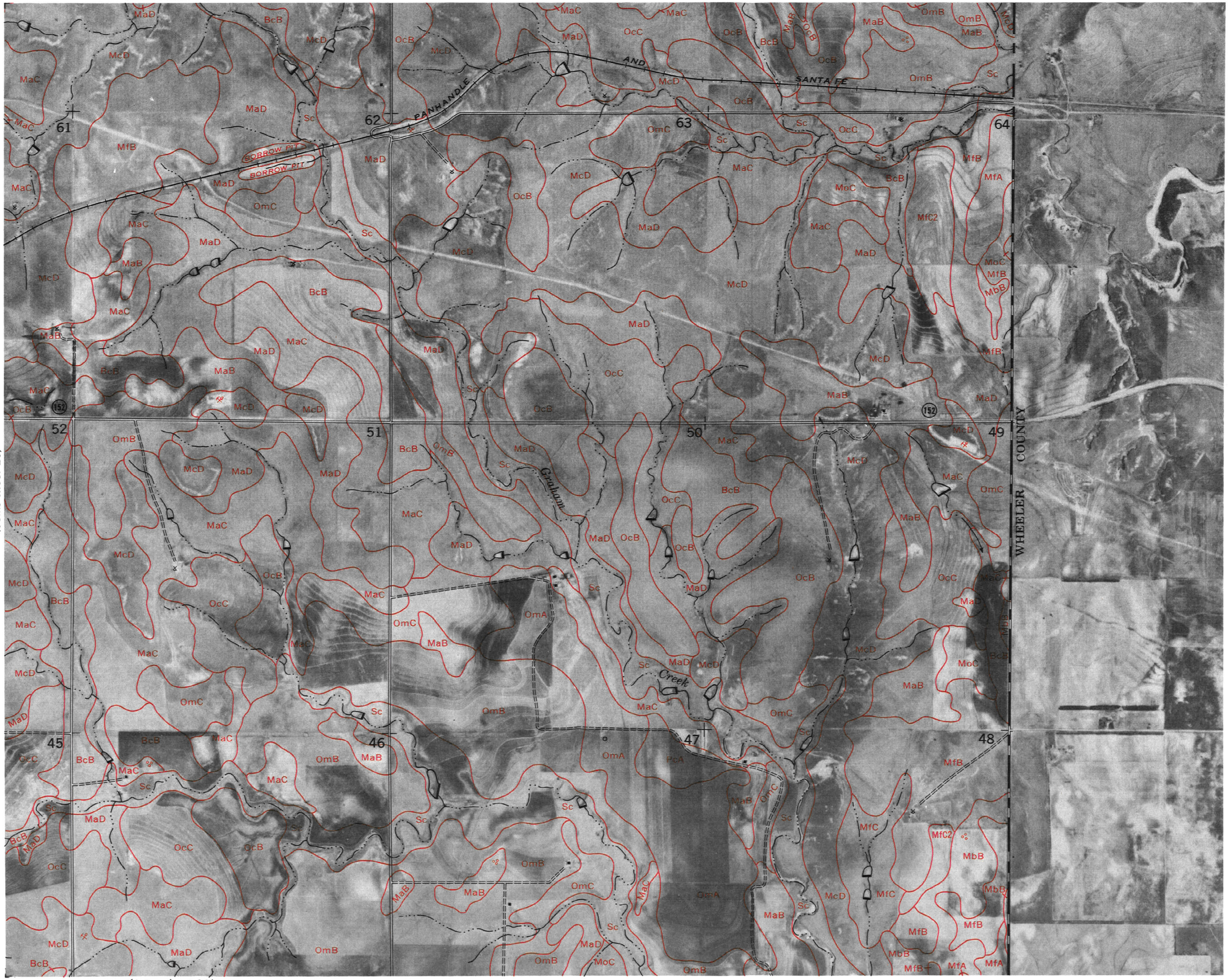
0 5000 Feet

21

N

(Joins sheet 14)

(Joins sheet 20)



(Joins sheet 28)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

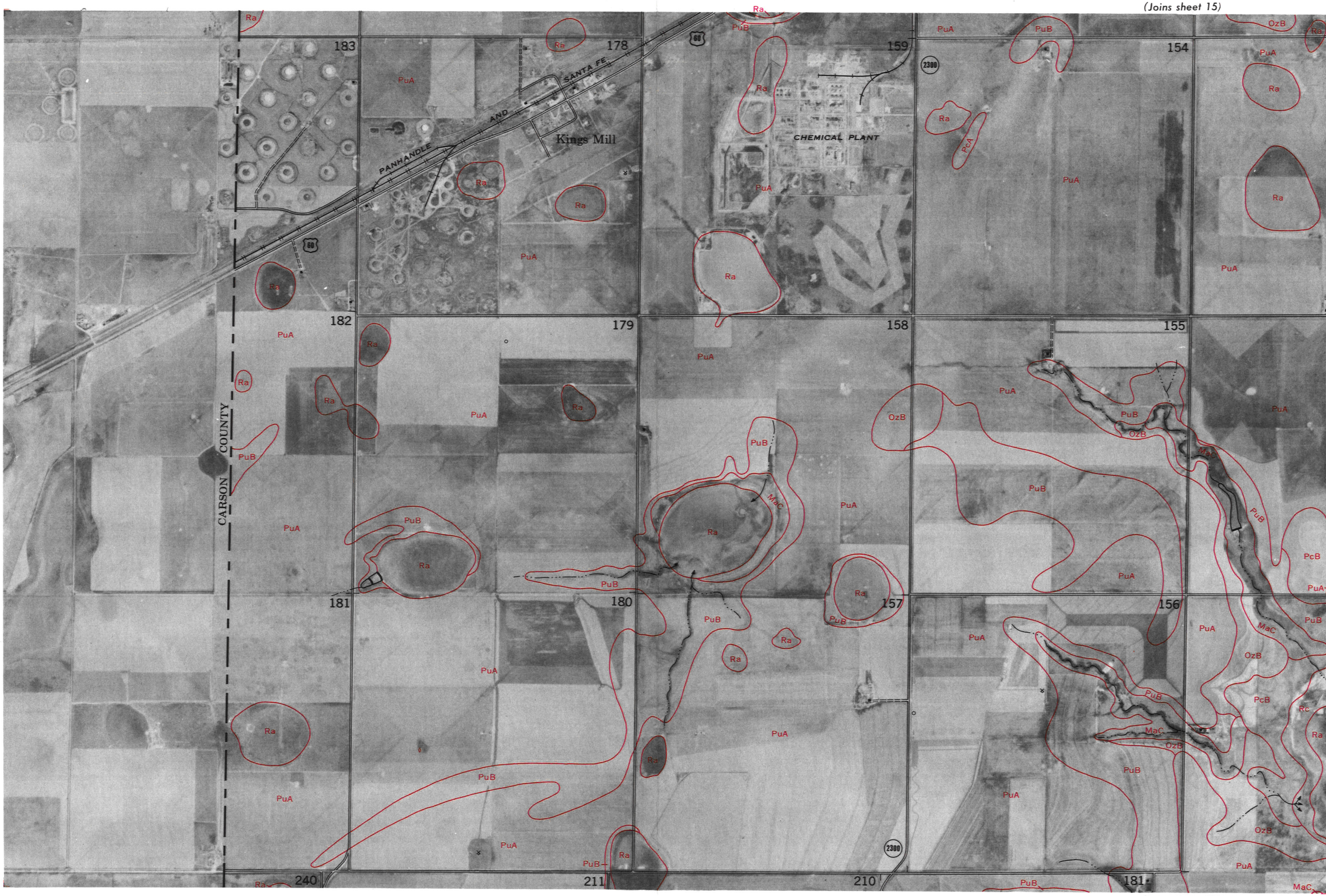
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

GRAY COUNTY, TEXAS — SHEET NUMBER 22

(Joins sheet 15)

N



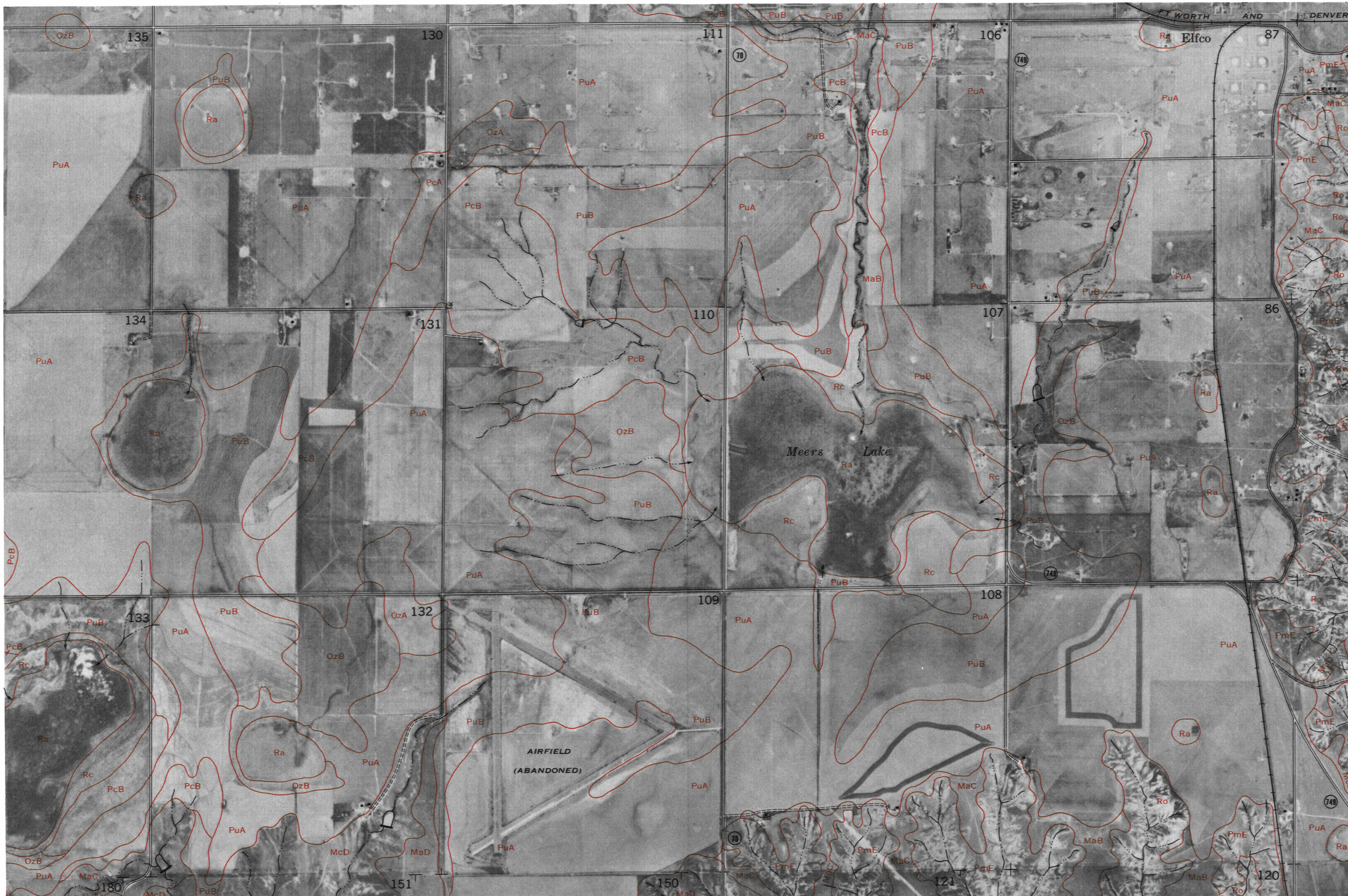
(Joins sheet 23)

(Joins sheet 29)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

23

(Joins sheet 16)



(Joins sheet 22)

(Joins sheet 24)

(Joins sheet 30)

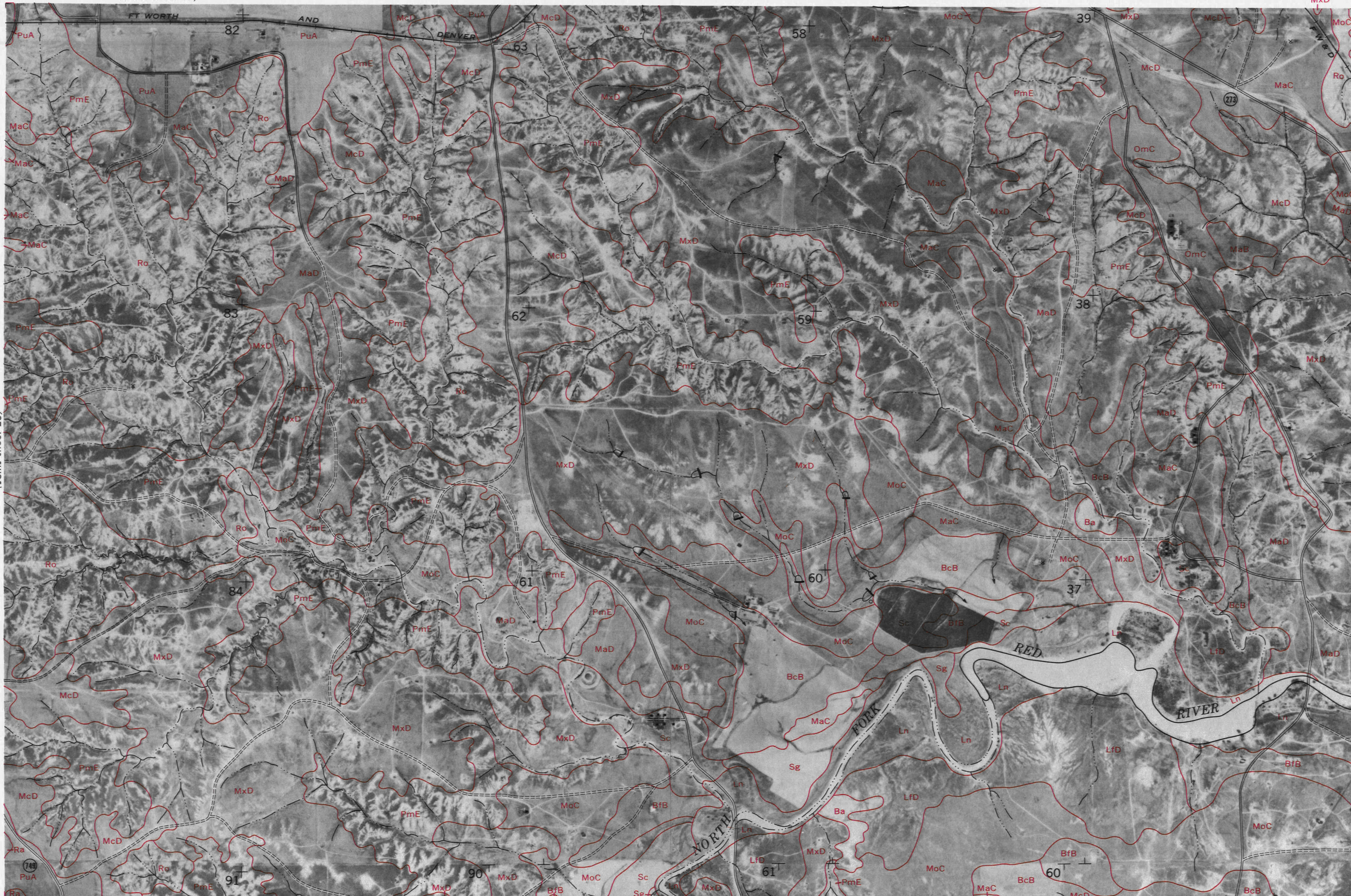
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

24

(Joins sheet 17)



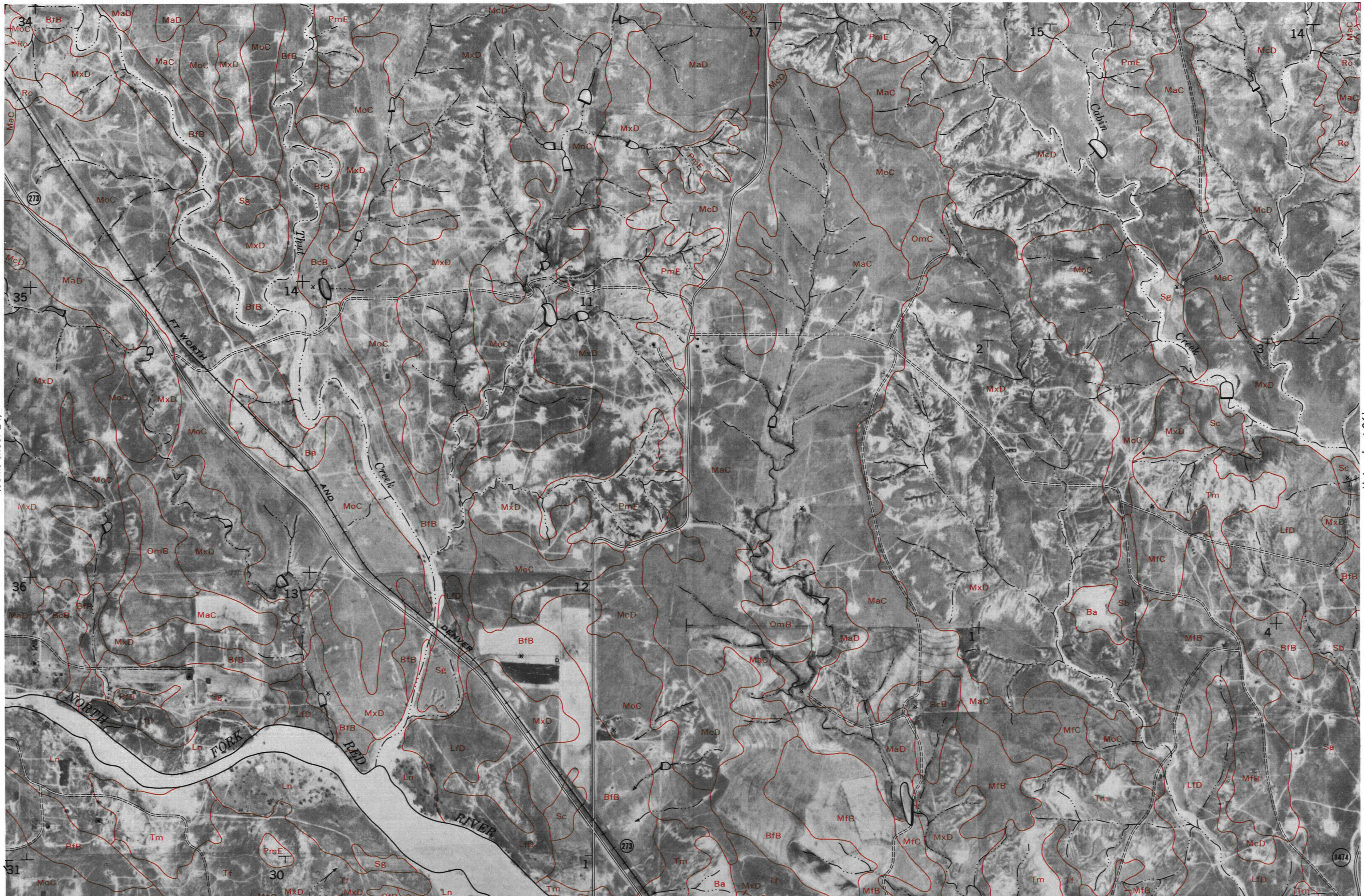
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

GRAY COUNTY, TEXAS — SHEET NUMBER 25

(25)

(Joins sheet 18)

(Joins sheet 24)



(Joins sheet 26)

(Joins sheet 32)

N

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

0 ½ 1 Mile

Scale 1:20 000

0 5000 Feet

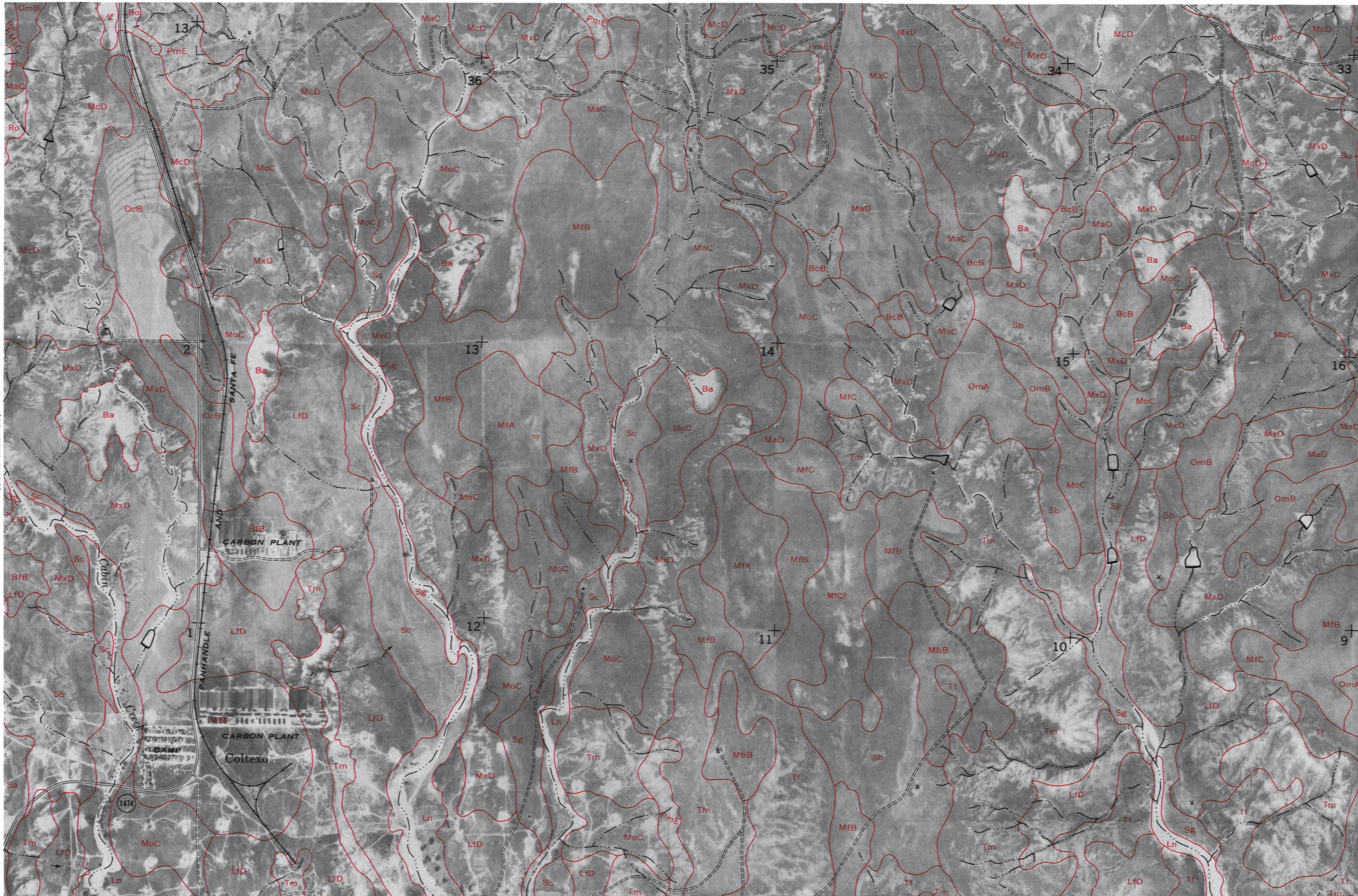
26

GRAY COUNTY, TEXAS — SHEET NUMBER 26

(Joins sheet 19)

N

(Joins sheet 25)



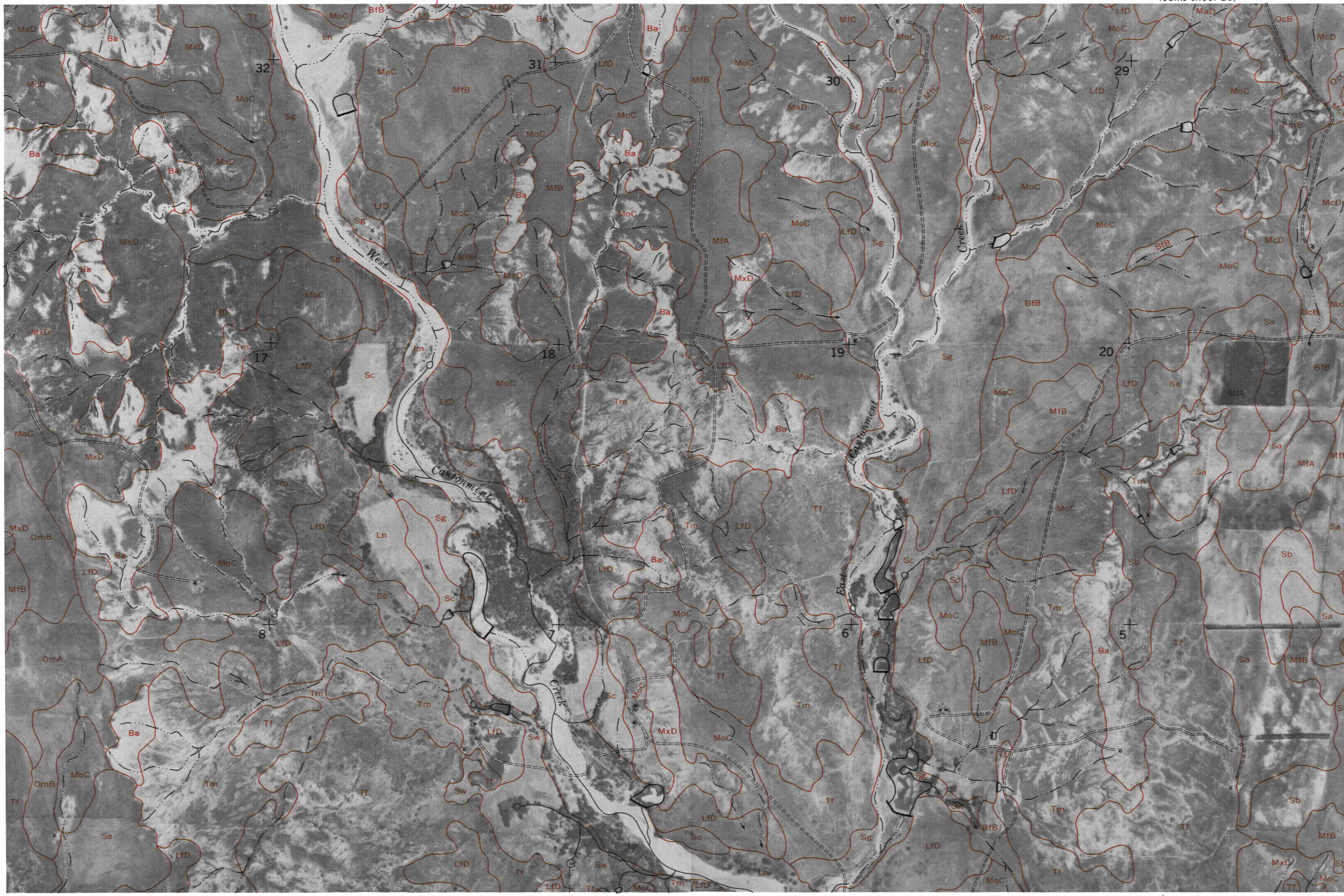
(Joins sheet 27)

(Joins sheet 33)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

27

(Joins sheet 20)



(Joins sheet 26)

(Joins sheet 28)

(Joins sheet 34)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

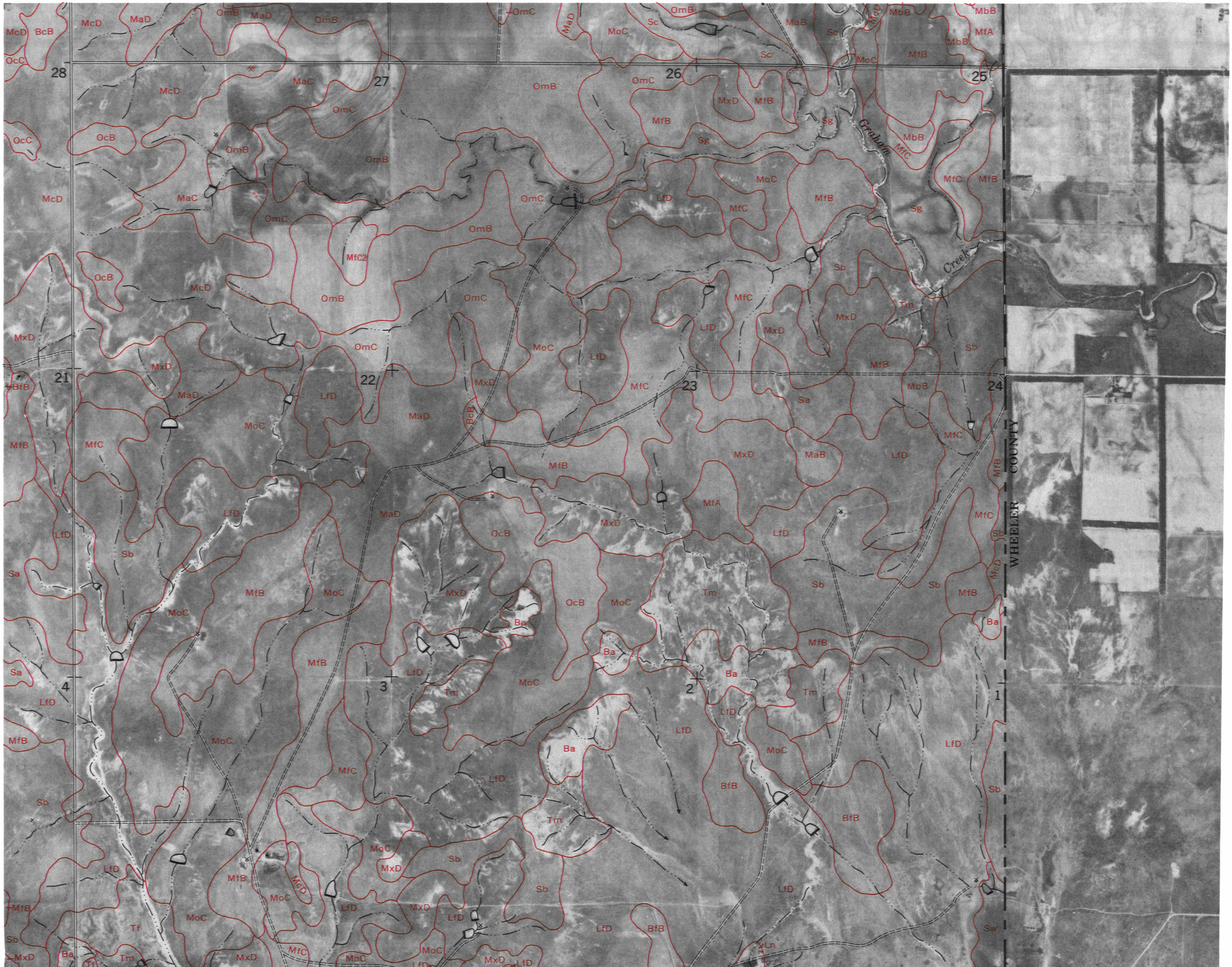
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

(Joins sheet 21)

N

(Joins sheet 27)



(Joins sheet 35)

0 ½ 1 Mile

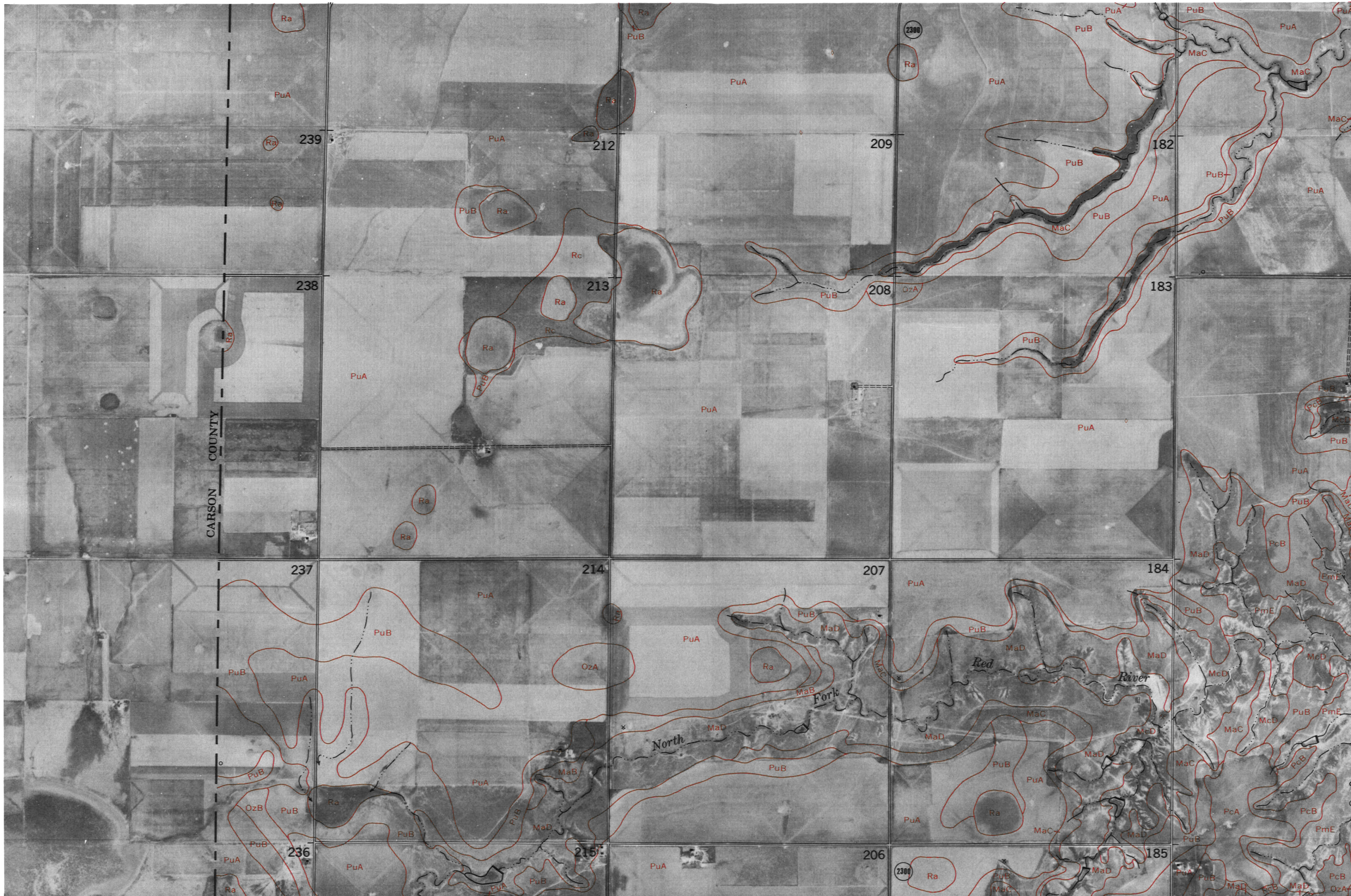
Scale 1: 20 000

0 5000 Feet

GRAY COUNTY, TEXAS — SHEET NUMBER 29

29

(Joins sheet 22)



(Joins sheet 30)

(Joins sheet 36)

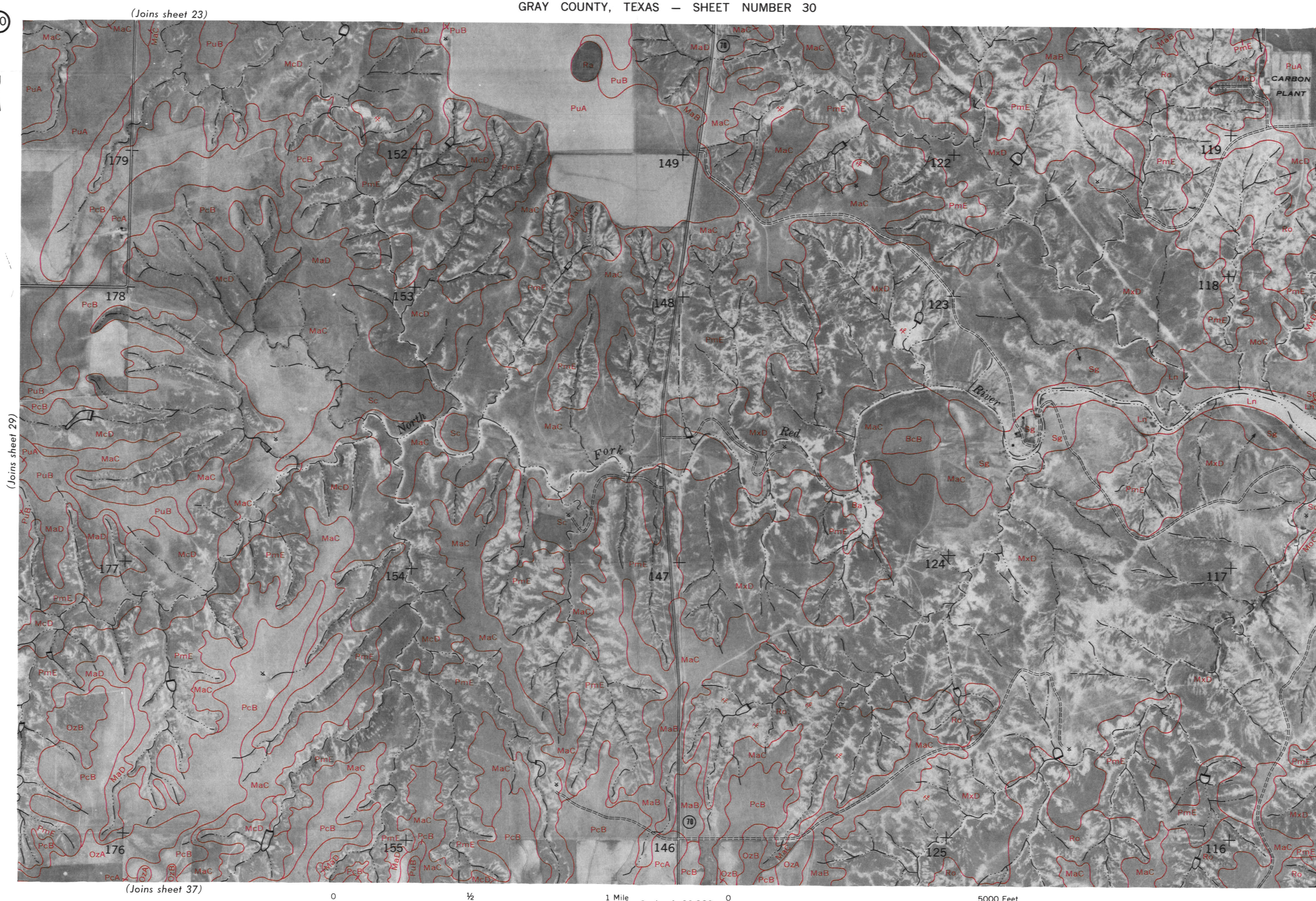
0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

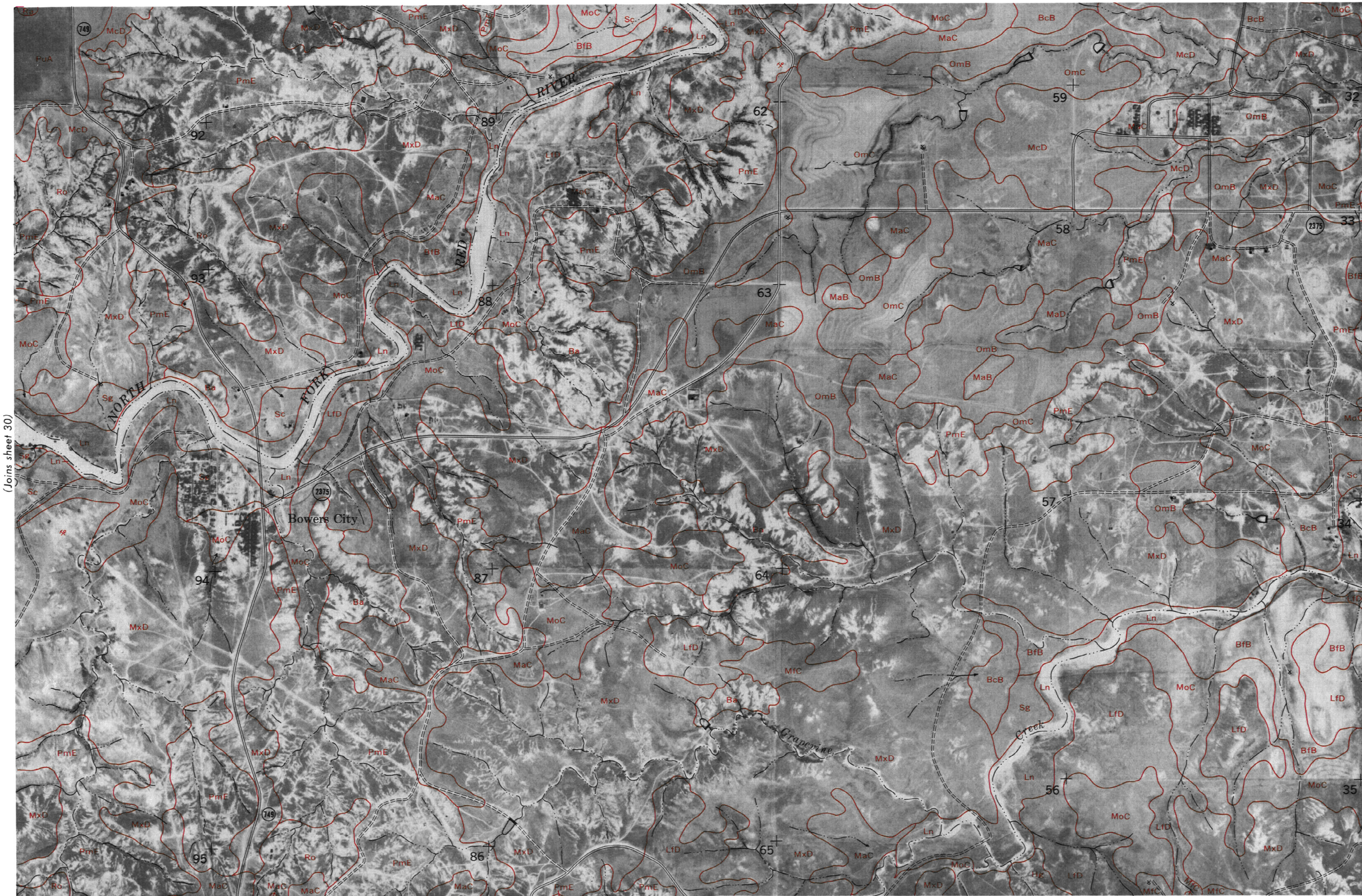
Land division corners and numbers shown on this map are indefinite.

30

GRAY COUNTY, TEXAS — SHEET NUMBER 30



(Joins sheet 24)



(Joins sheet 38)

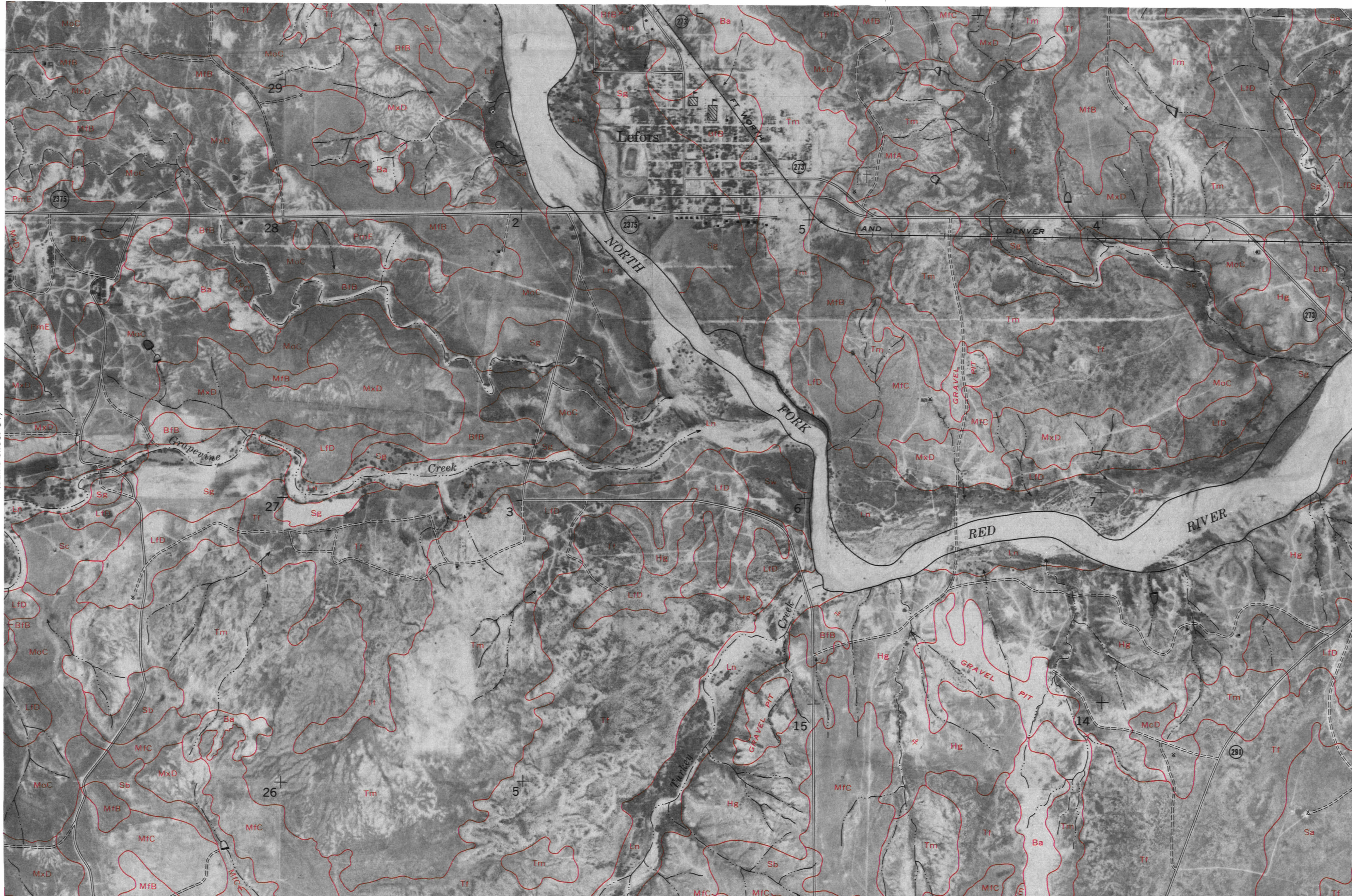
0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

GRAY COUNTY, TEXAS — SHEET NUMBER 32

(Joins sheet 25)



(Joins sheet 31)

(Joins sheet 33)

(Joins sheet 39)

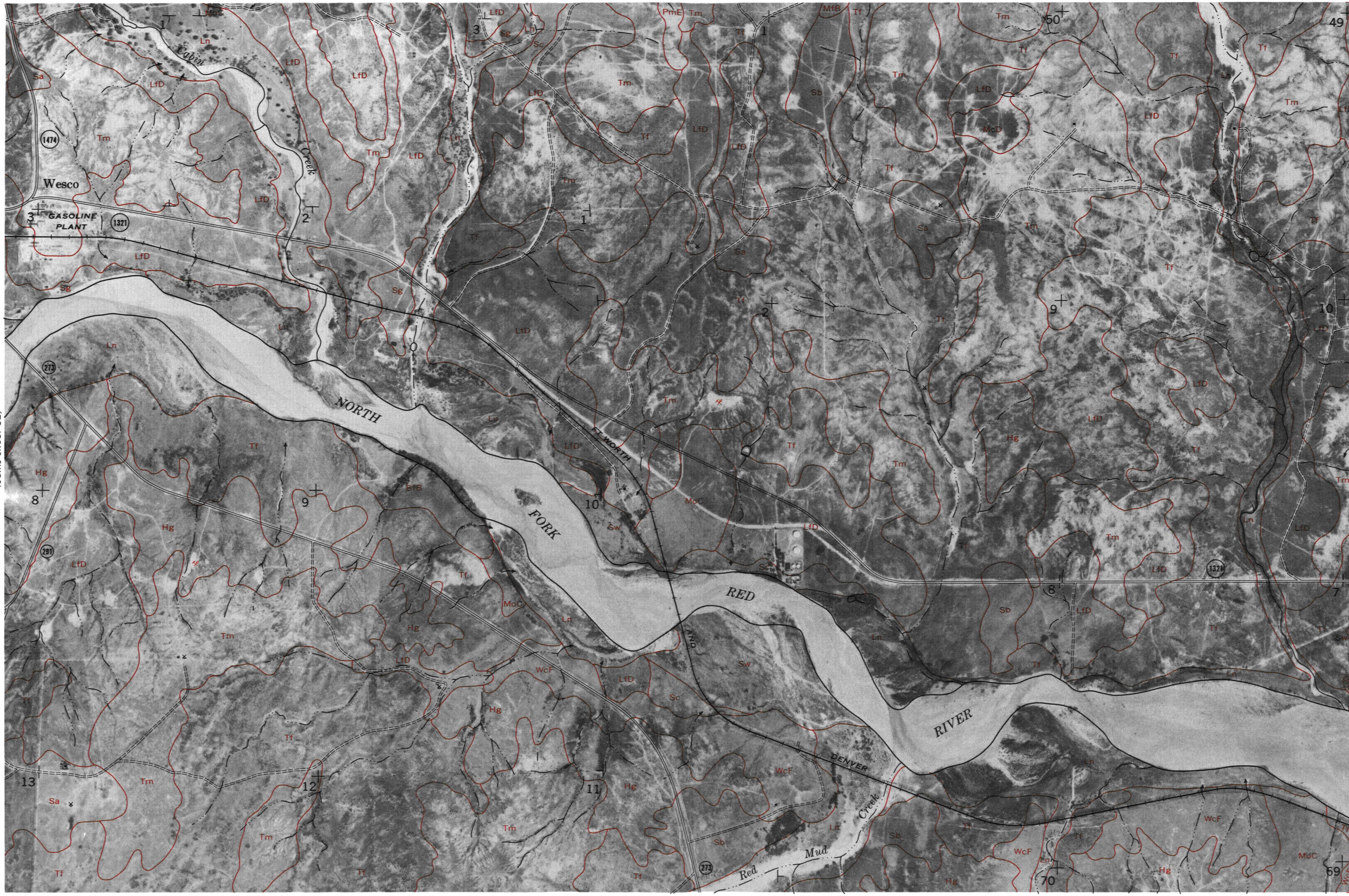
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

(33)

(Joins sheet 26)

(Joins sheet 32)

(Joins sheet 34)



(Joins sheet 40)

Scale 1:20 000

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

34

(Joins sheet 27)

(Joins sheet 41)

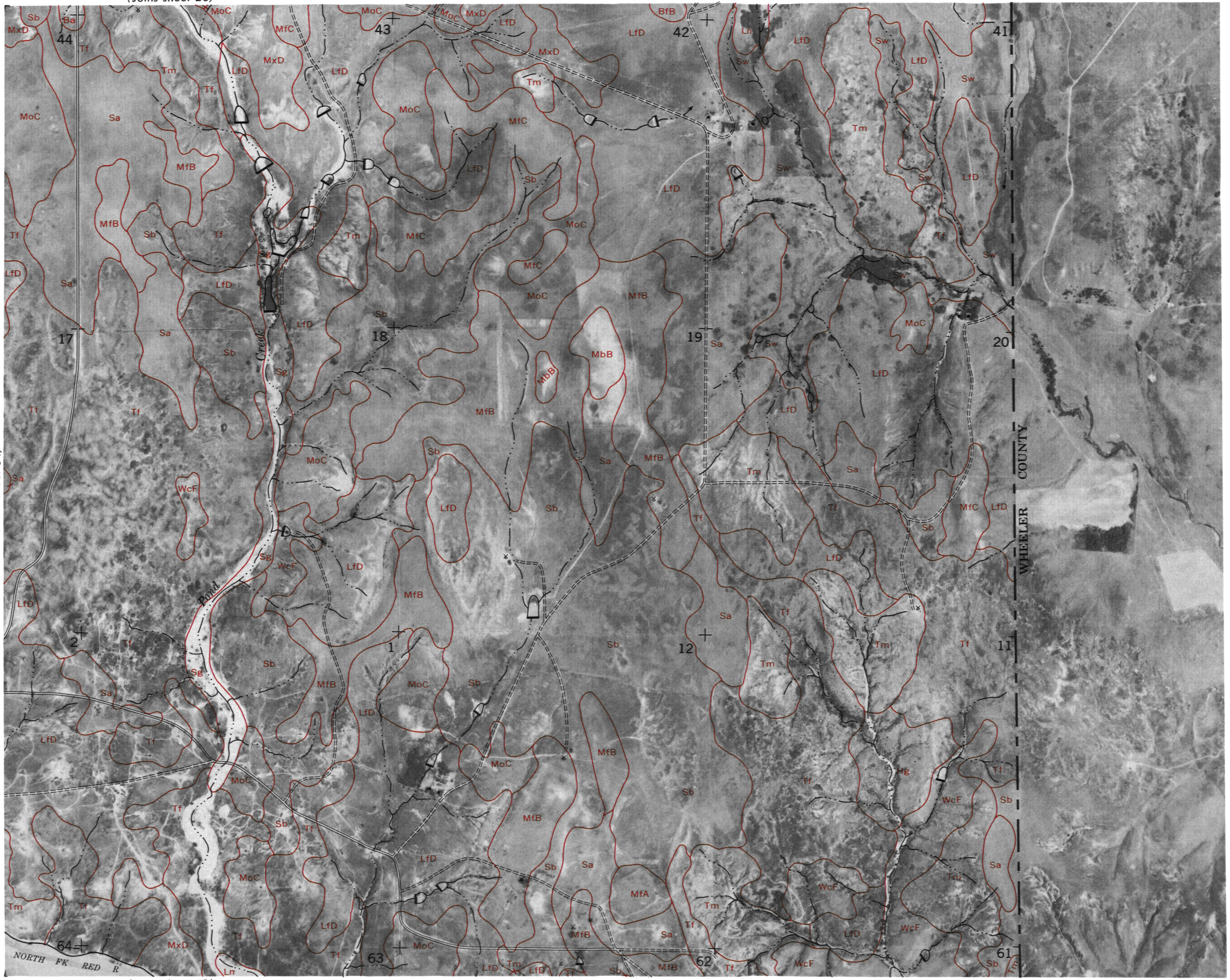
Scale 1: 20 000

0 ½ 1 Mile

0 5000 Feet

(Joins sheet 28)

(Joins sheet 34)



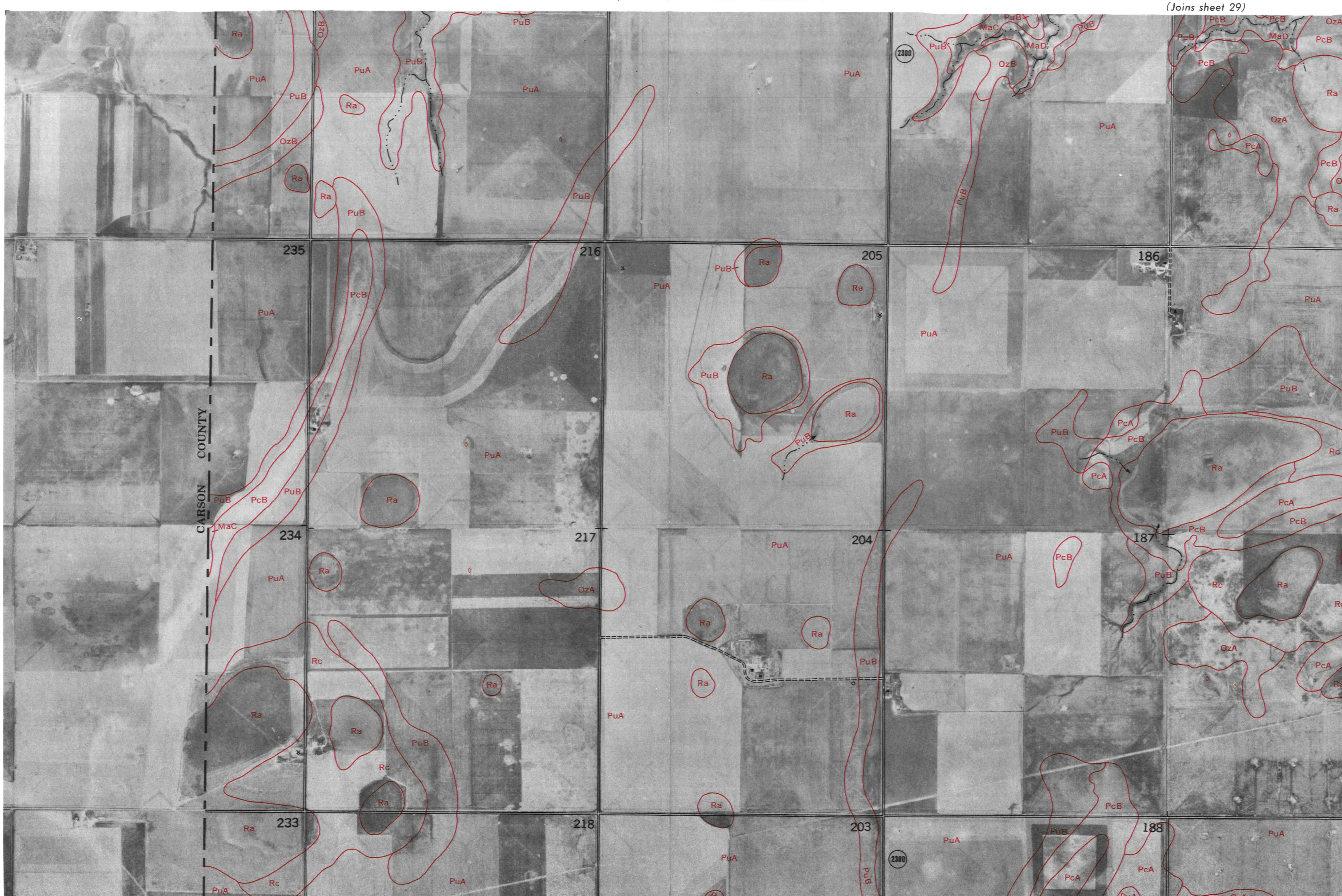
(Joins sheet 42)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

(Joins sheet 29)



(Joins sheet 43)

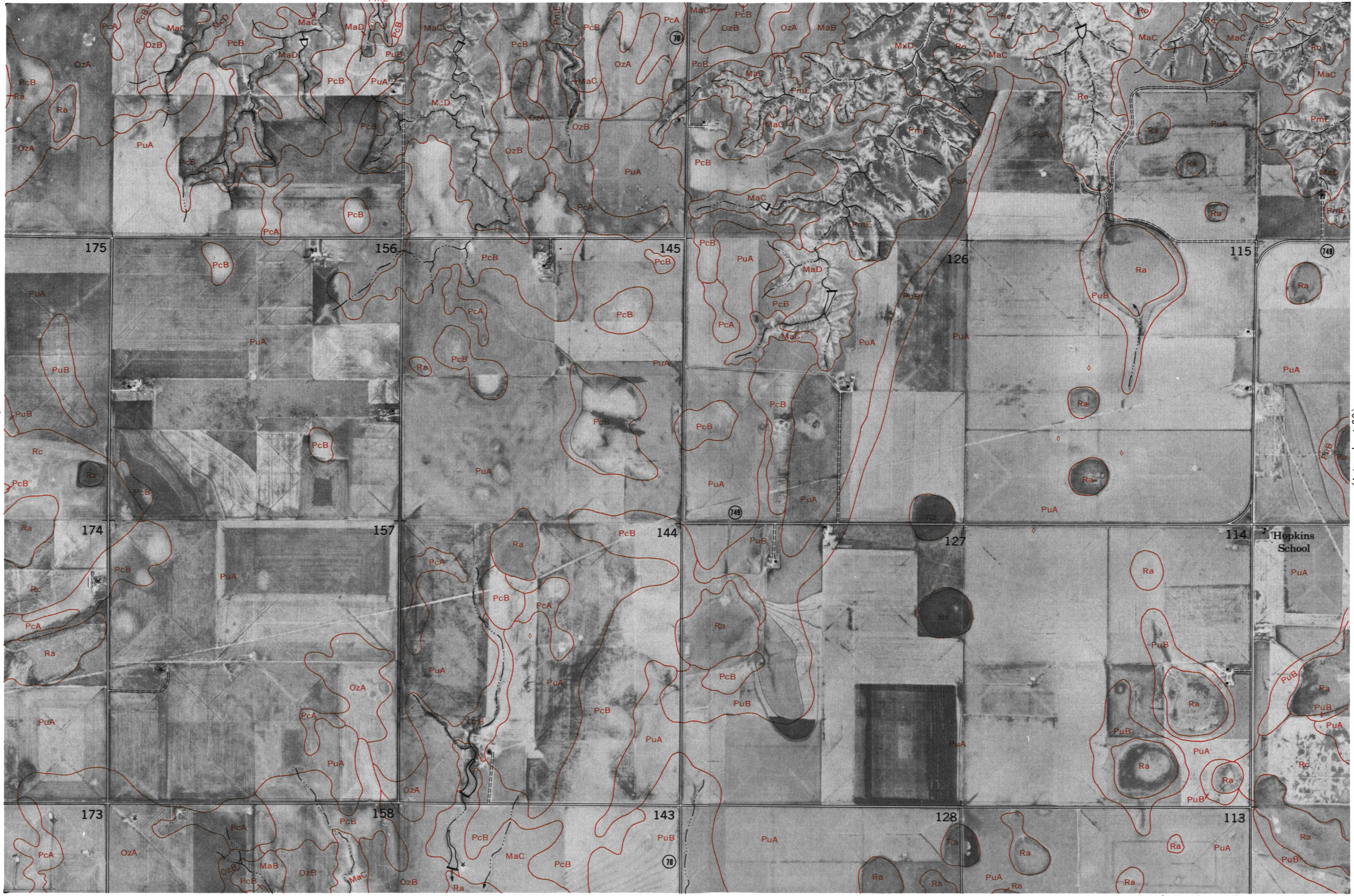
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

(Joins sheet 30)

37

N

(Joins sheet 36)



(Joins sheet 38)

(Joins sheet 44)

0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

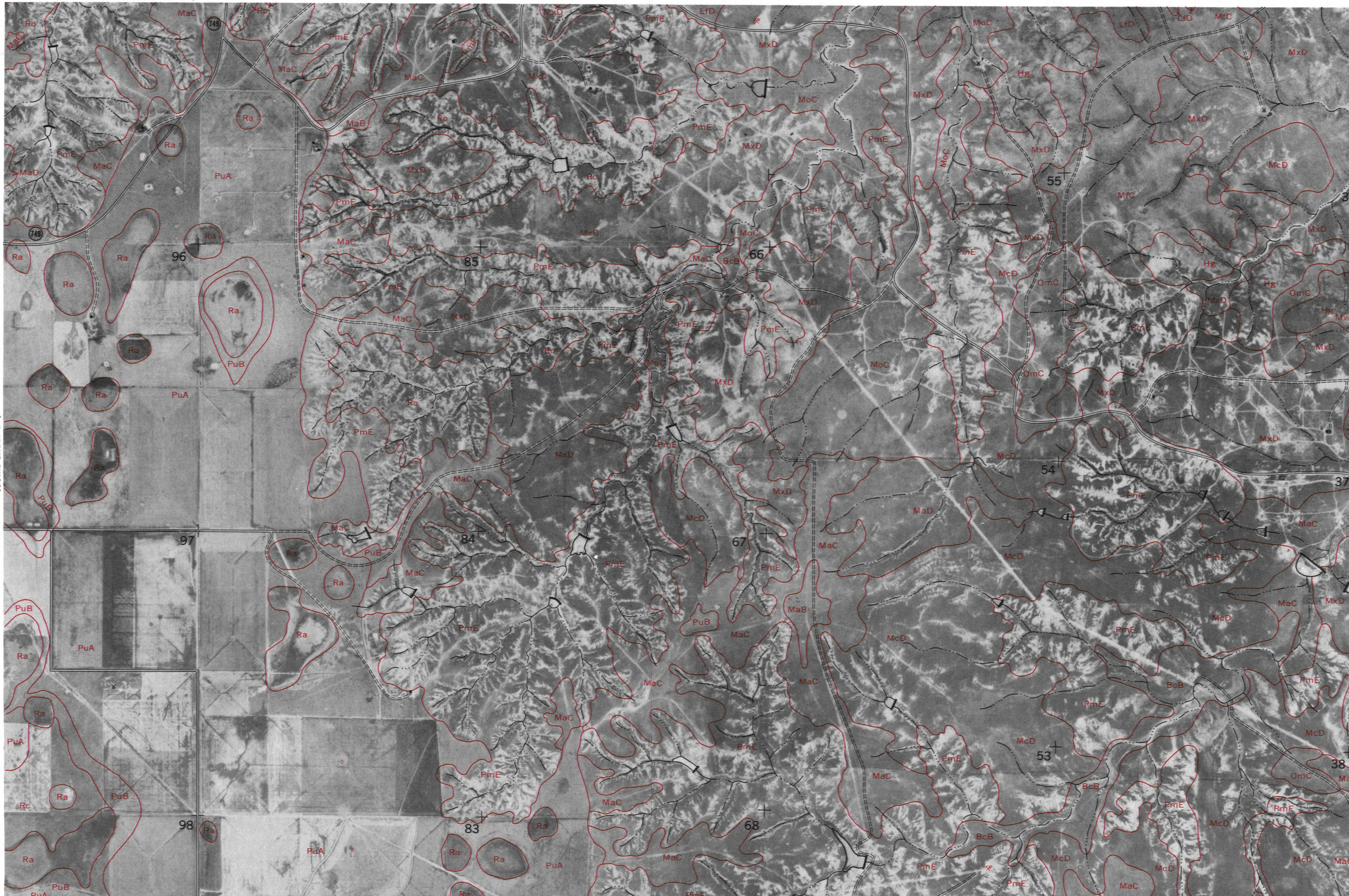
Land division corners and numbers shown on this map are indefinite.

38

GRAY COUNTY, TEXAS — SHEET NUMBER 38

(Joins sheet 31)

(Joins sheet 37)



(Joins sheet 39)

(Joins sheet 45)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

GRAY COUNTY, TEXAS — SHEET NUMBER 39

(Joins sheet 32)

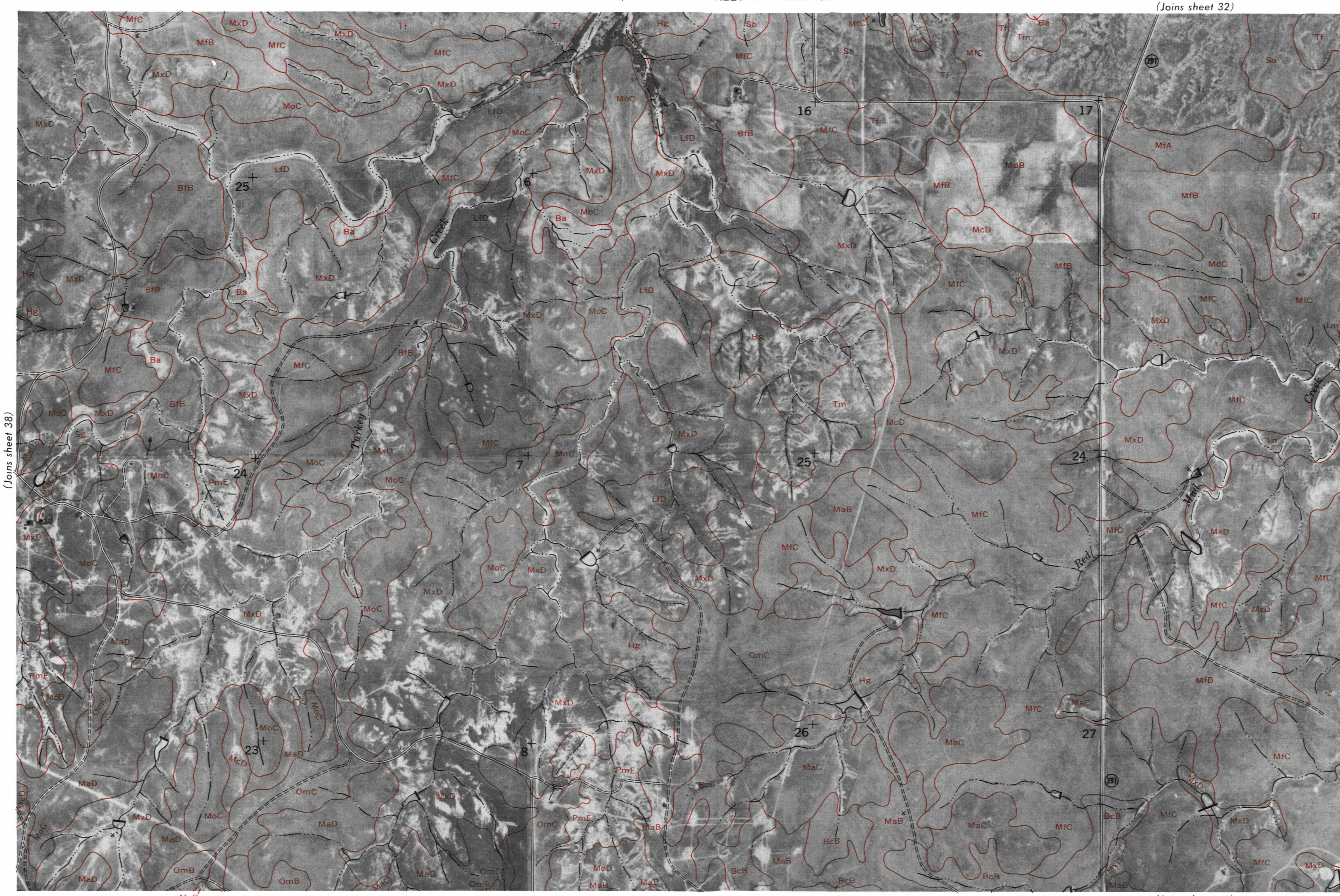
39

N

his map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture,
nd the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

(Joins sheet 38)



(Joins sheet 40)

McD

(Joins sheet 46)

0 ½ 1 Mile

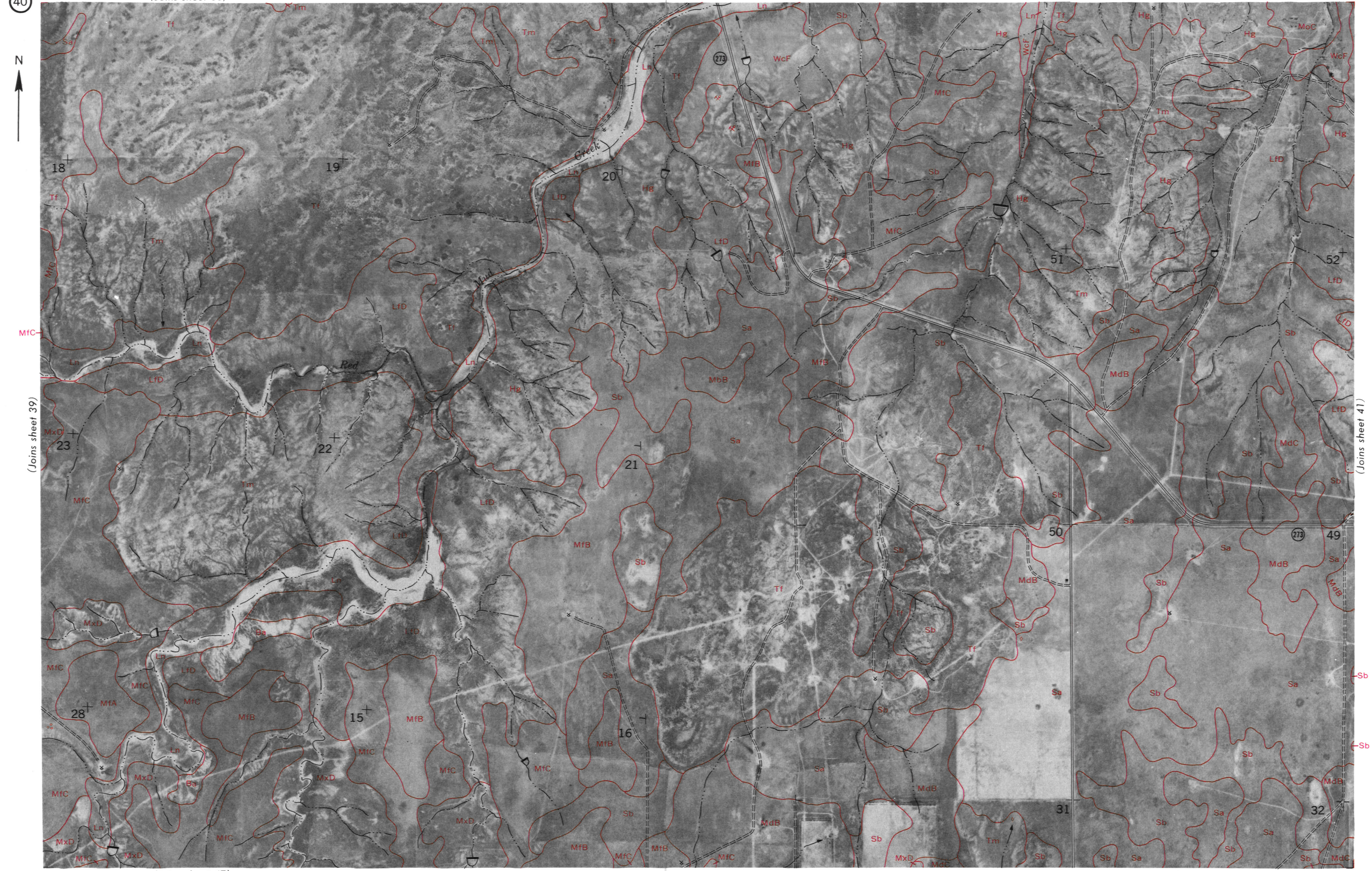
Scale 1: 20 000

0 5000 Feet

GRAY COUNTY, TEXAS — SHEET NUMBER 40

(Joins sheet 33)

(Joins sheet 39)



(Joins sheet 41)

(Joins sheet 47)

0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

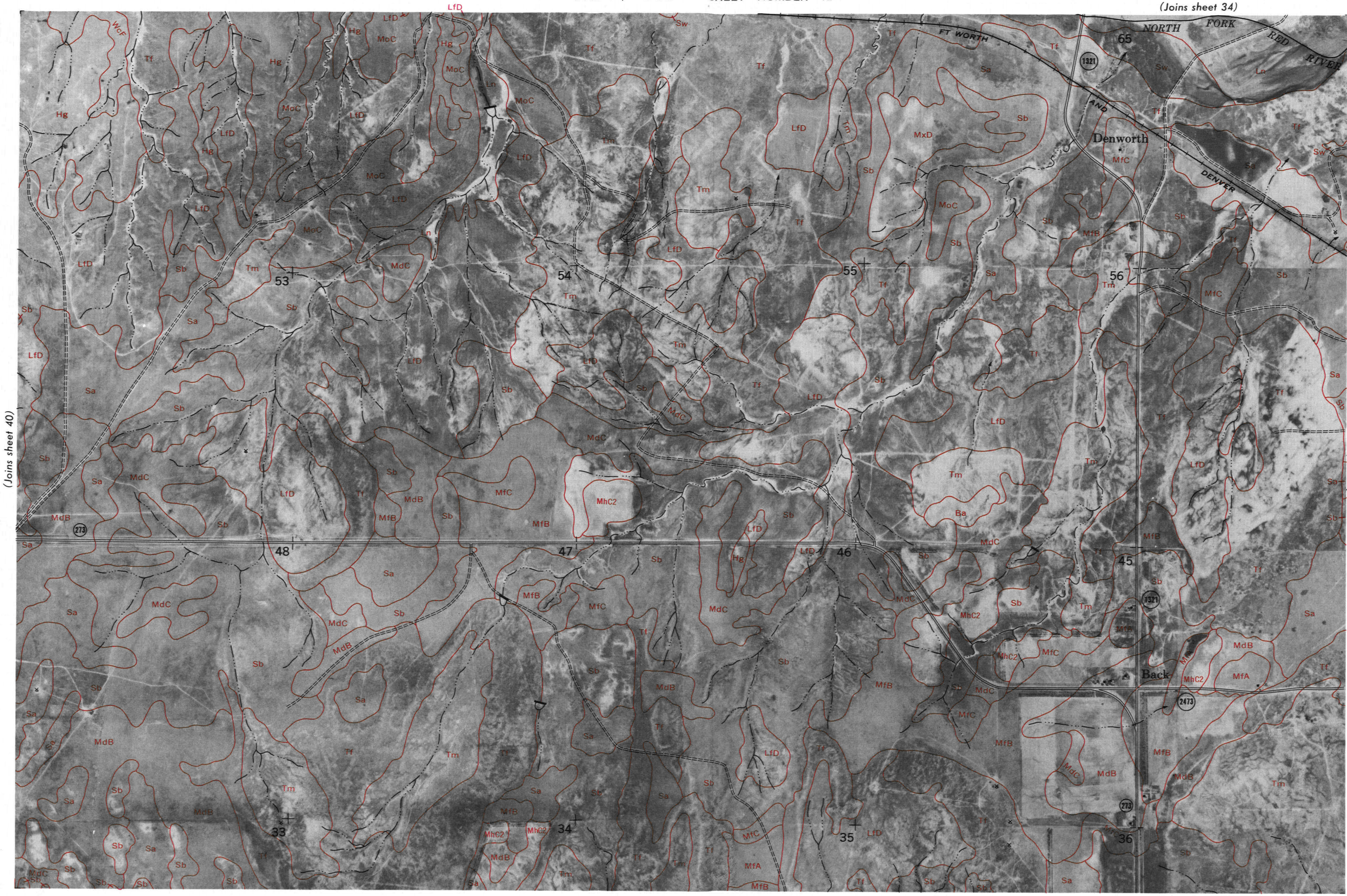
(Joins sheet 34)

41

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

(Joins sheet 40)



(Joins sheet 42)

(Joins sheet 48)

0 ½ 1 Mile

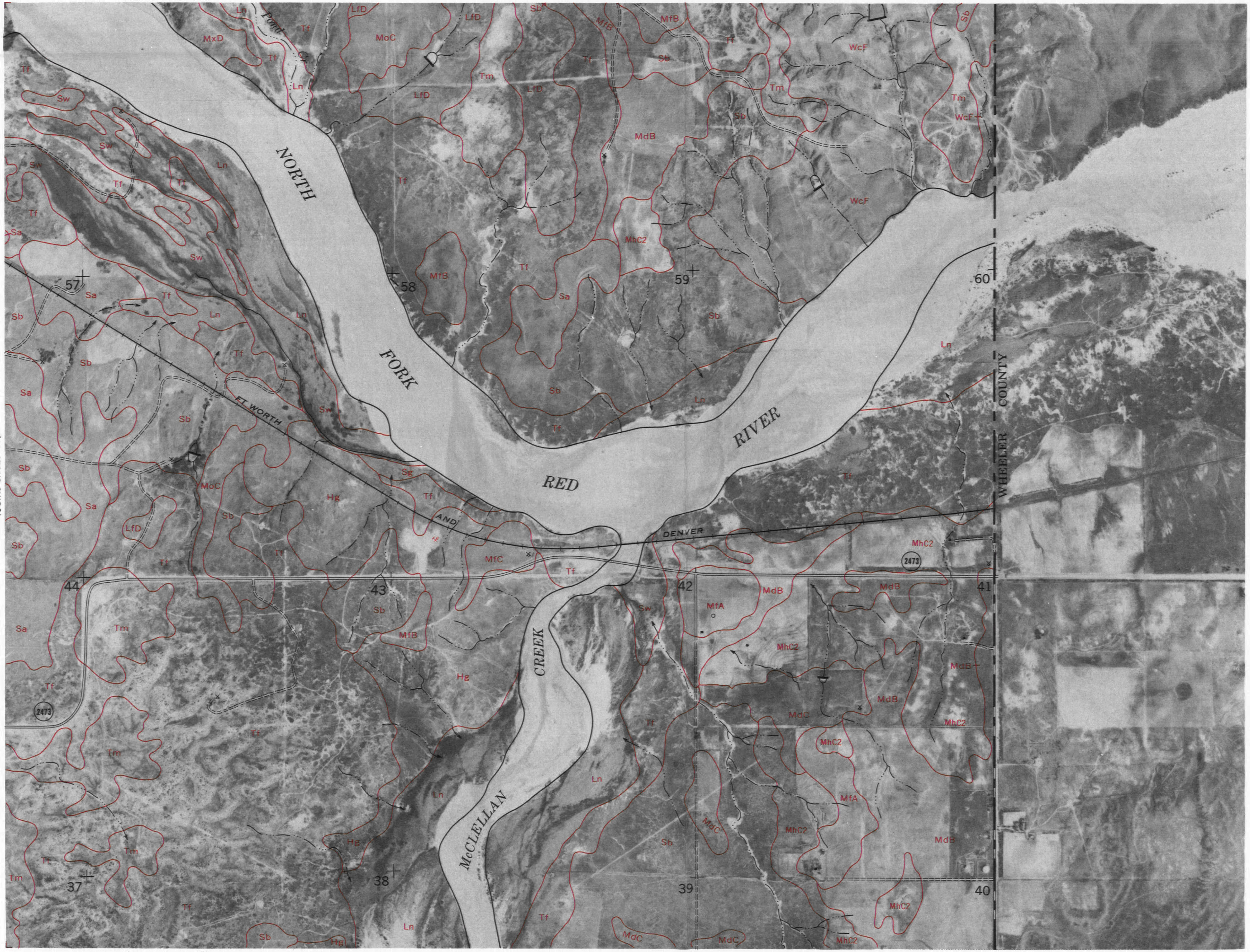
Scale 1: 20 000

0 5000 Feet

(Joins sheet 35)

N

(Joins sheet 41)



(Joins sheet 49)

0 ½ 1 Mile

Scale 1:20 000

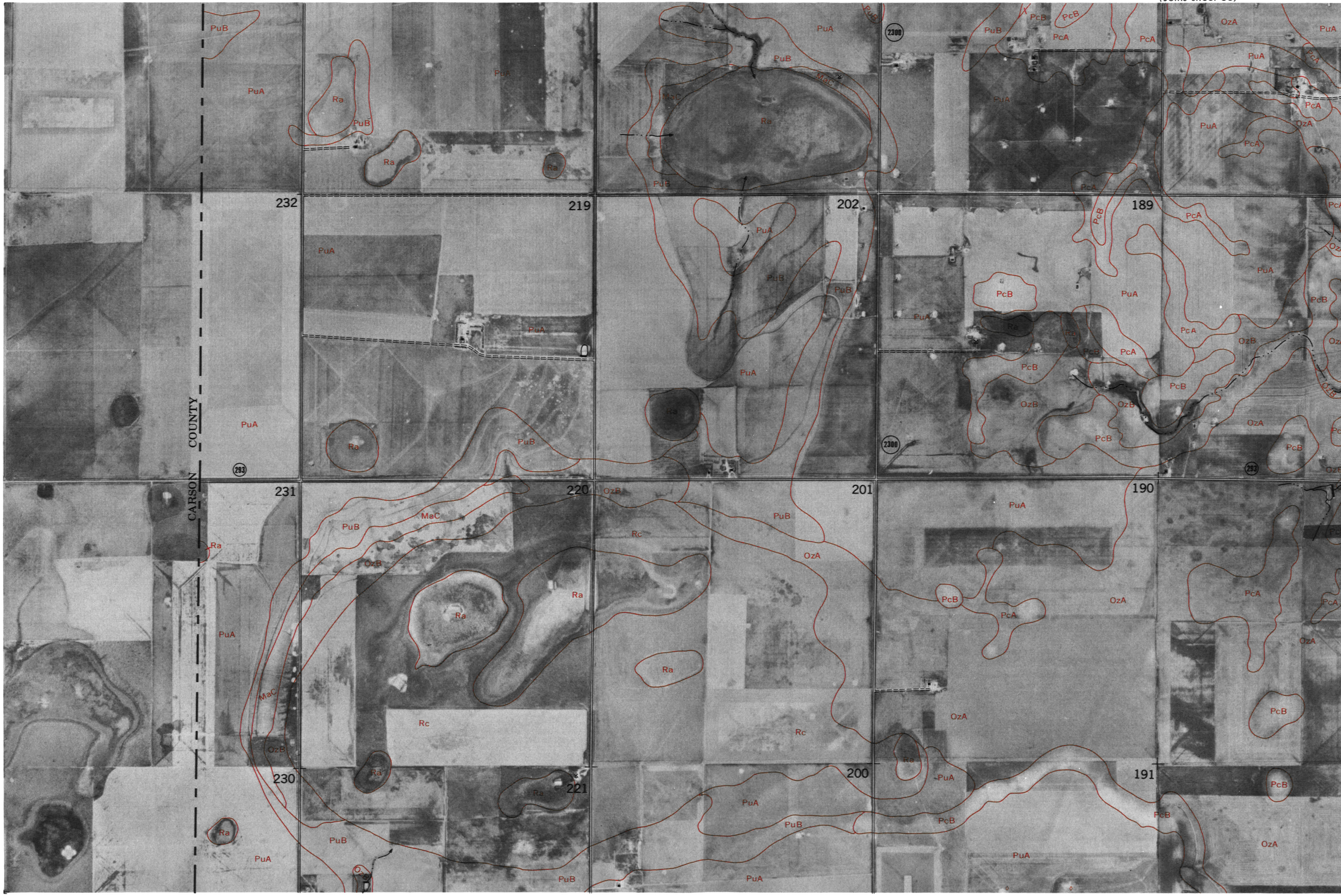
0 5000 Feet

(Joins sheet 36)

43

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.



(Joins sheet 44)

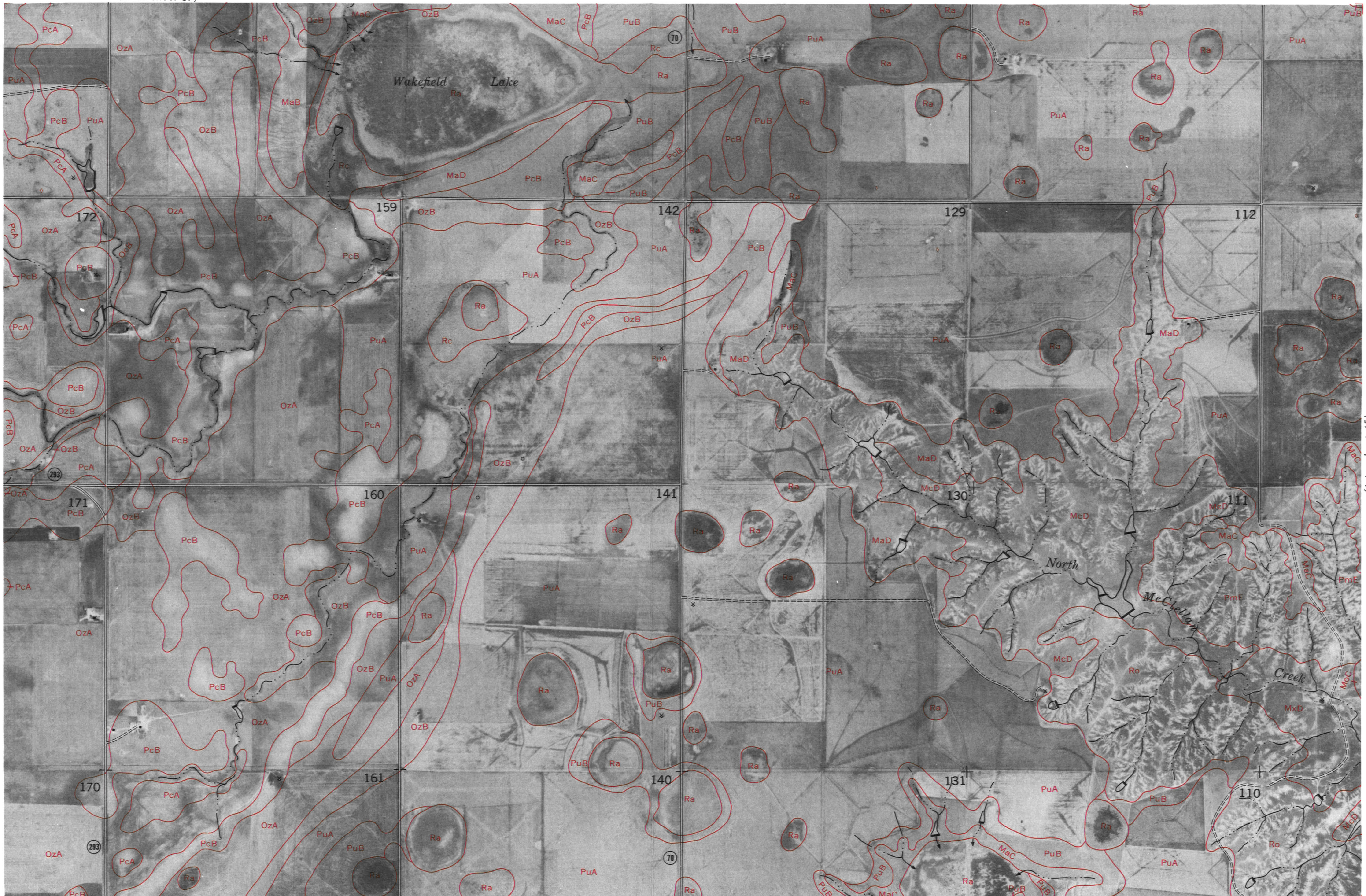
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

(Joins sheet 50)

44

(Joins sheet 37)

(Joins sheet 43)

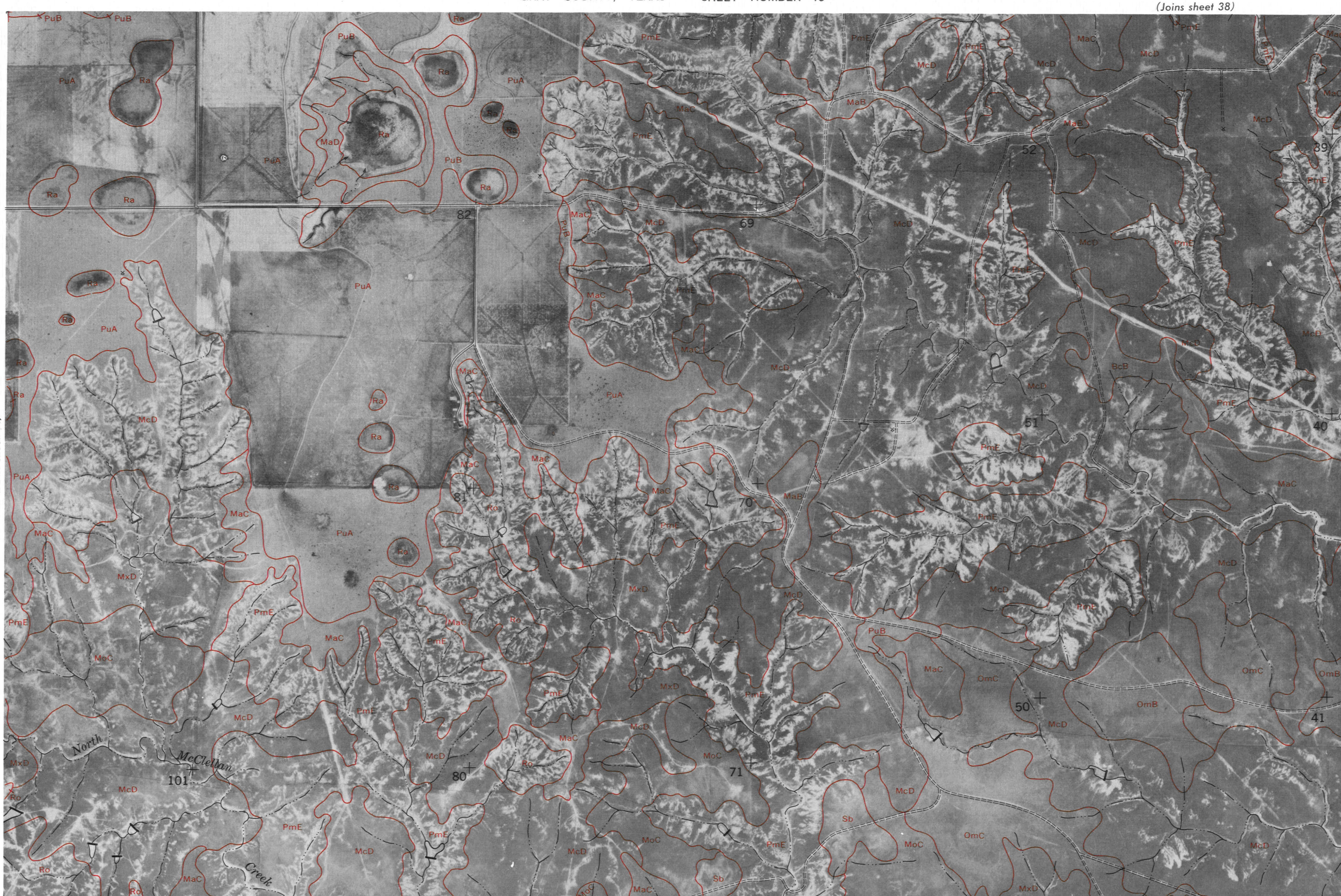


(Joins sheet 45)

(Joins sheet 51)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

GRAY COUNTY, TEXAS — SHEET NUMBER 45



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

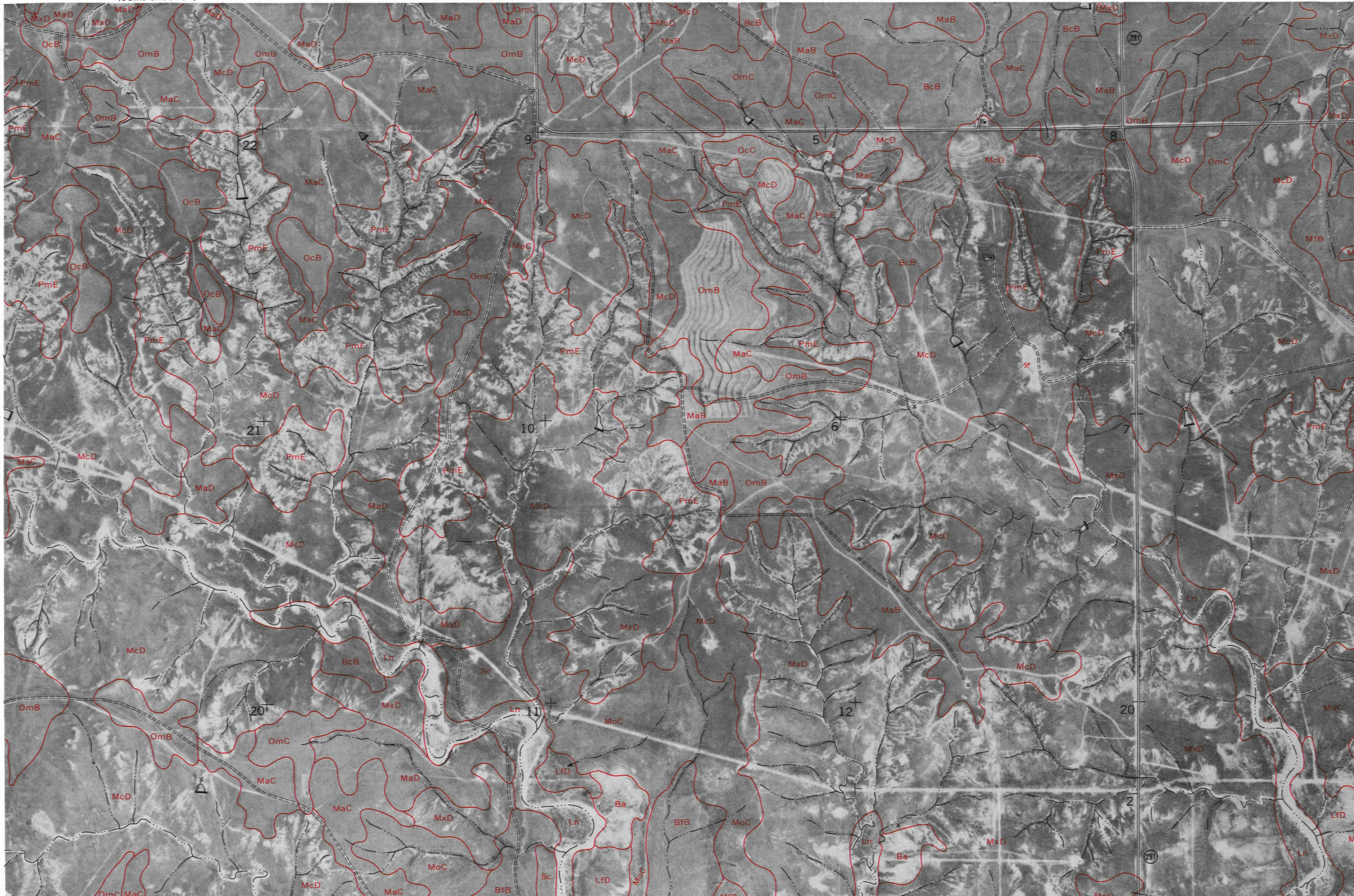
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

GRAY COUNTY, TEXAS — SHEET NUMBER 46

(Joins sheet 39)

(Joins sheet 45)



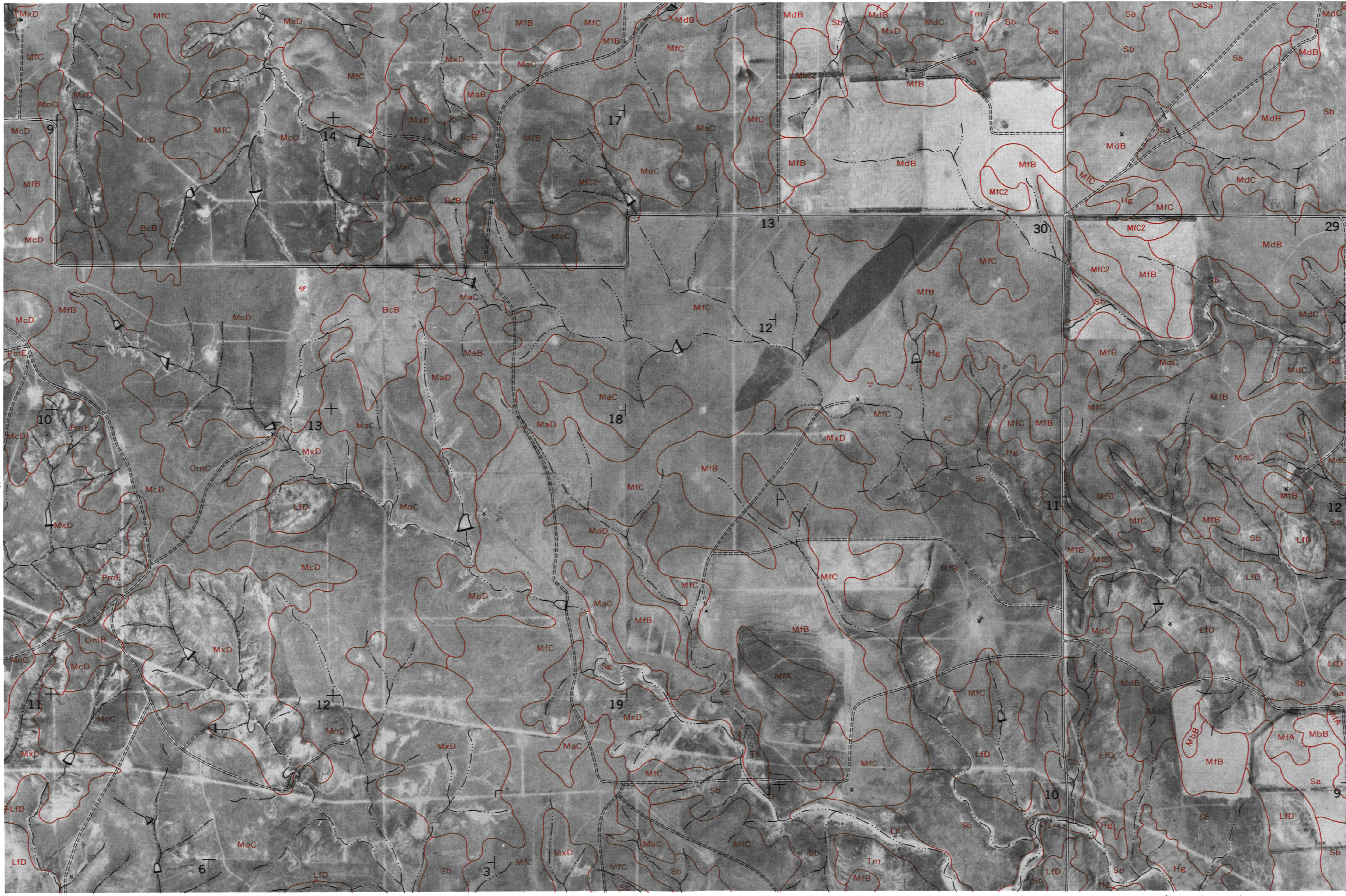
(Joins sheet 47)

(Joins sheet 53)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.



0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

48

(Joins sheet 41)

N

(Joins sheet 47)

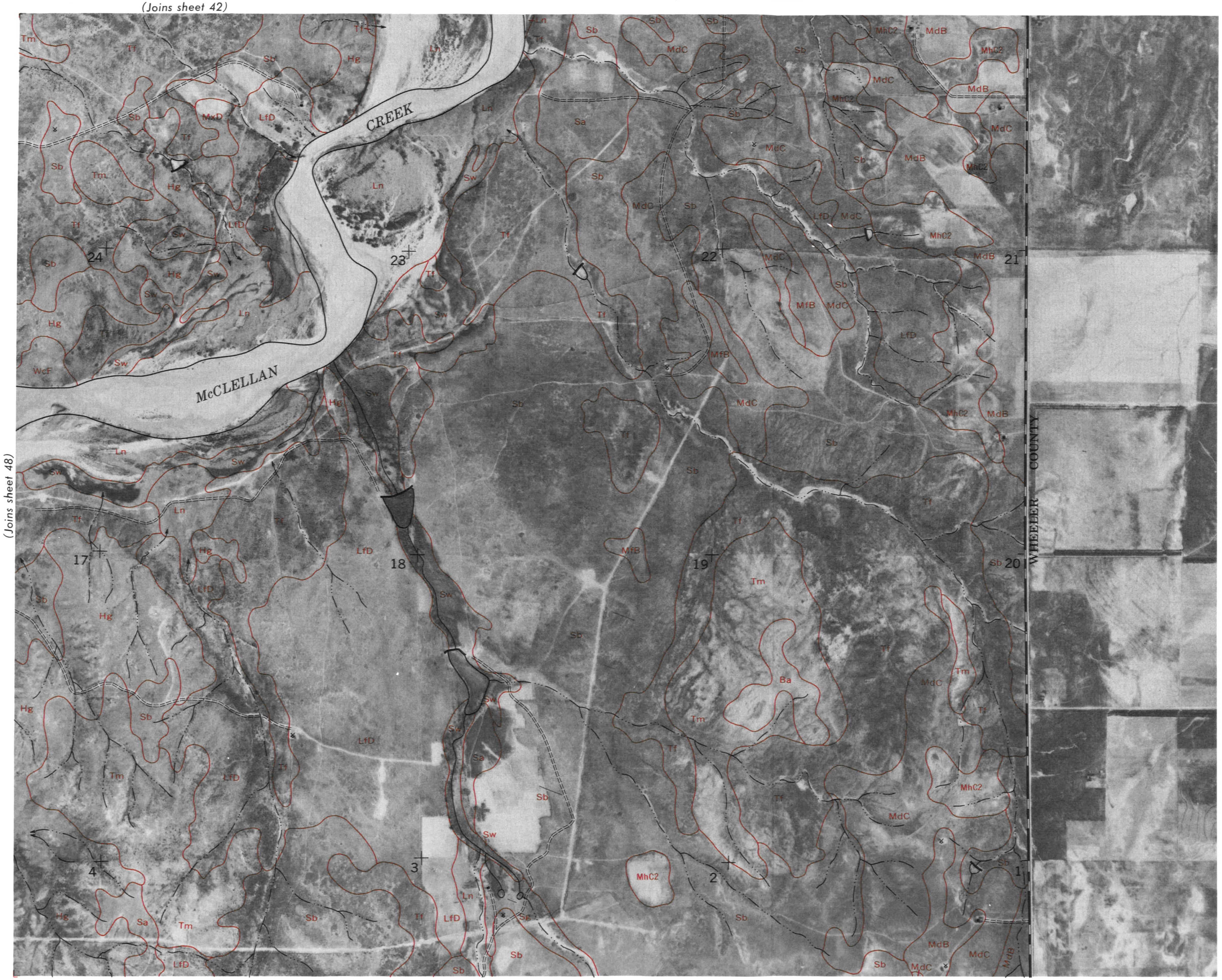
(Joins sheet 49)

(Joins sheet 55)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

(Joins sheet 42)

(Joins sheet 48)



(Joins sheet 56)

0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

N

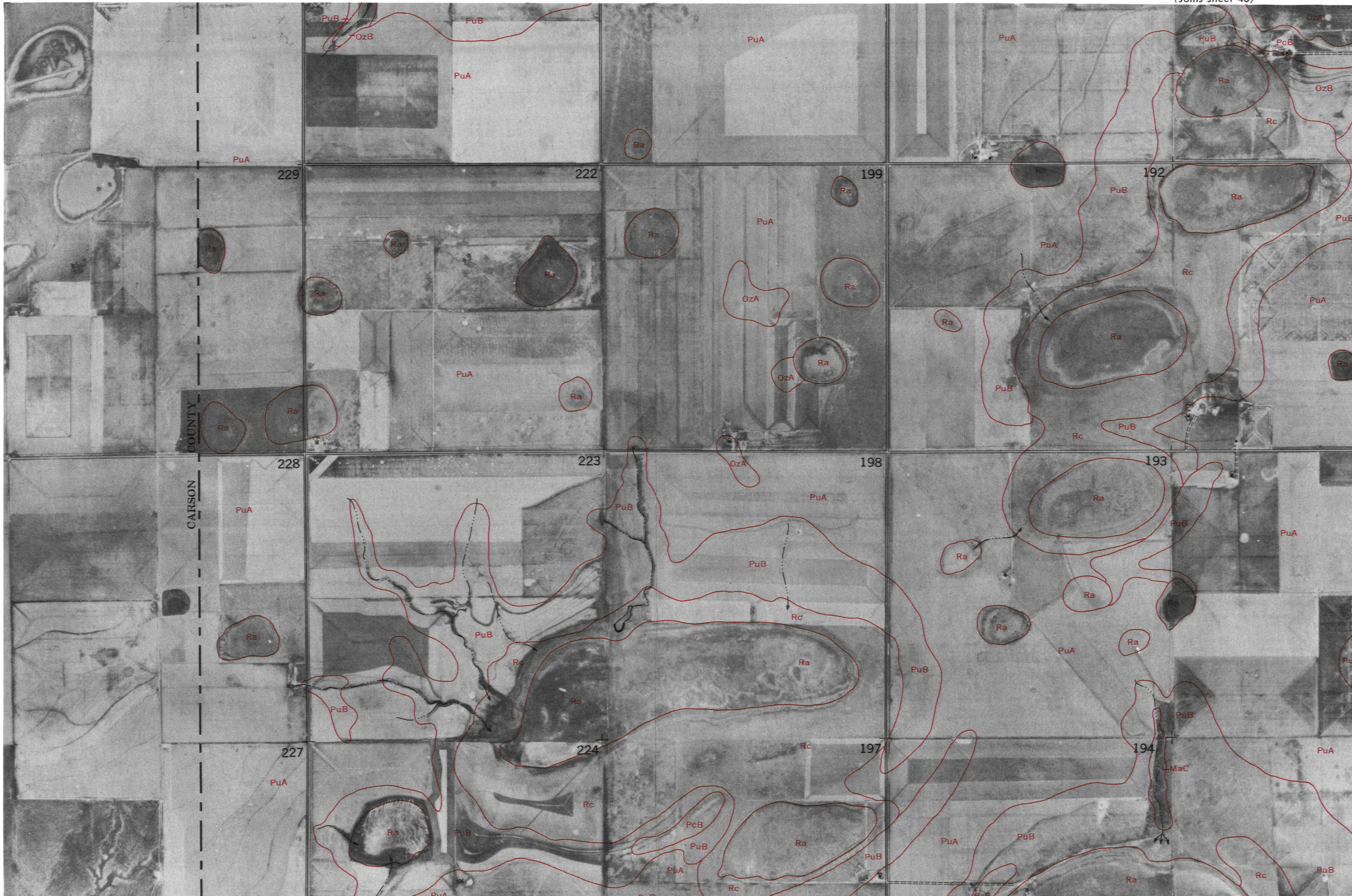
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

50

(Joins sheet 43)

N



(Joins sheet 51)

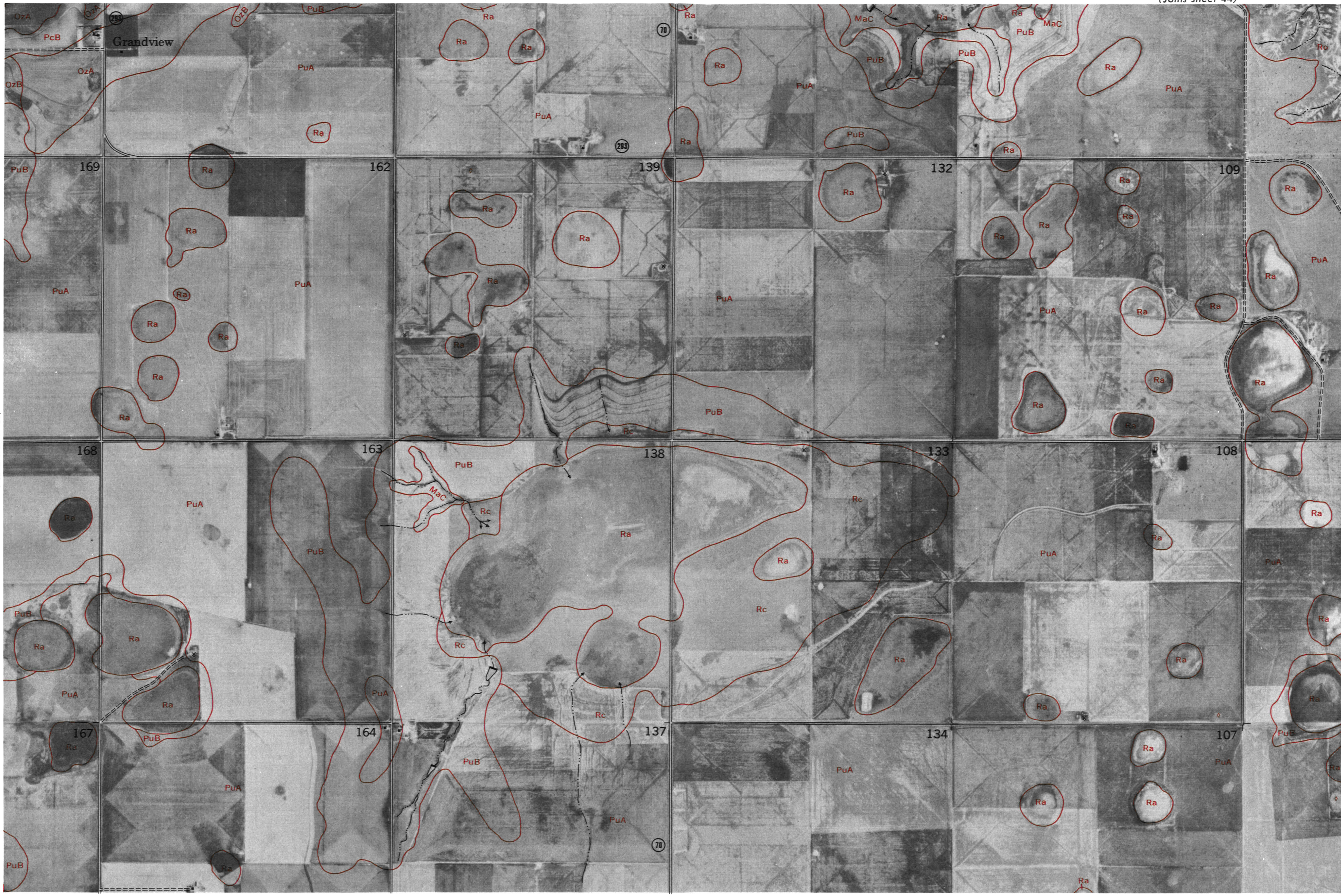
(Joins sheet 57)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

(Joins sheet 44)

(Joins sheet 50)

(Joins sheet 52)



(Joins sheet 58)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

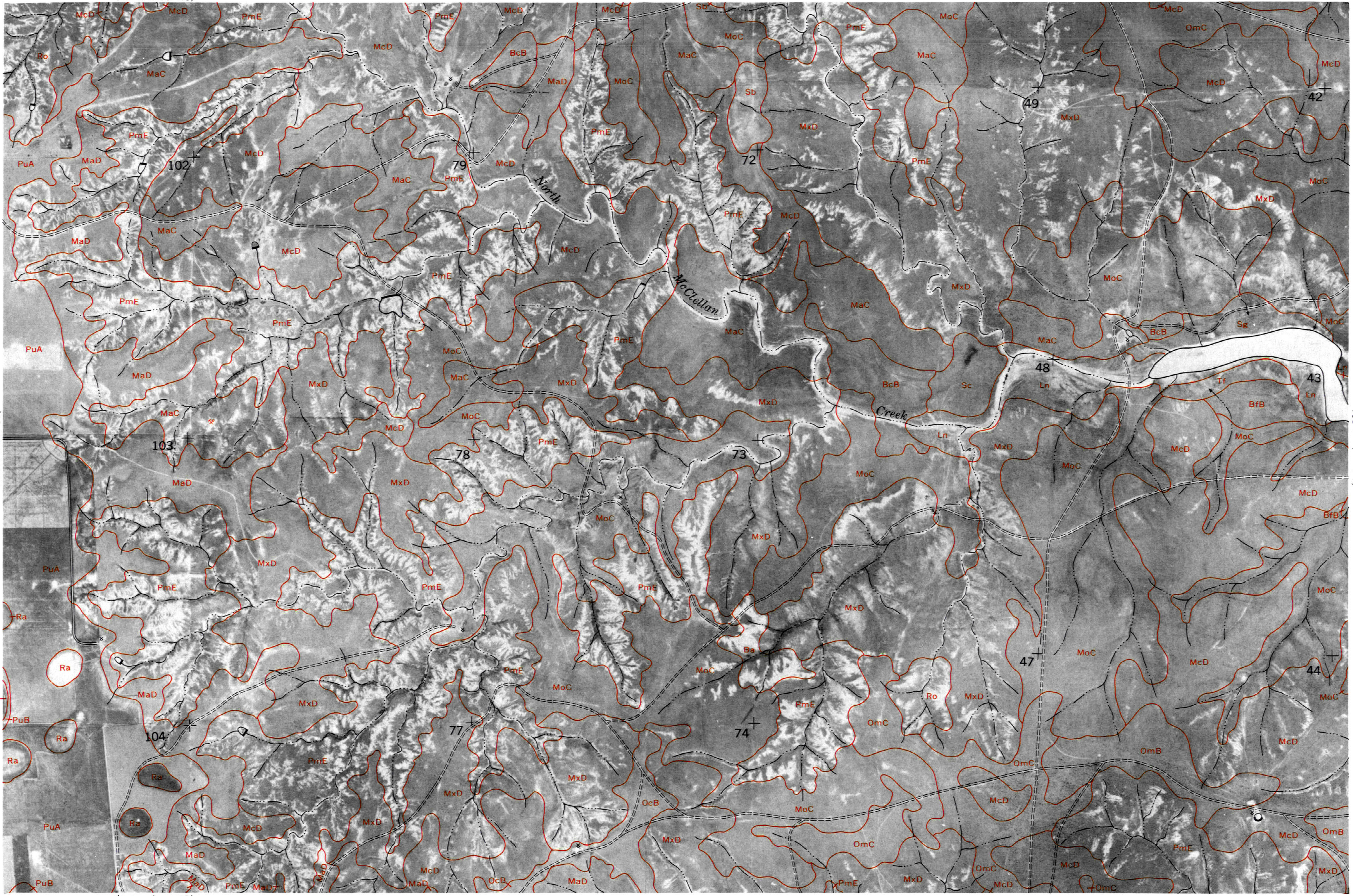
Land division corners and numbers shown on this map are indefinite.

52

(Joins sheet 45)

N

(Joins sheet 51)



(Joins sheet 53)

(Joins sheet 59)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

(Joins sheet 46)

(Joins sheet 60)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

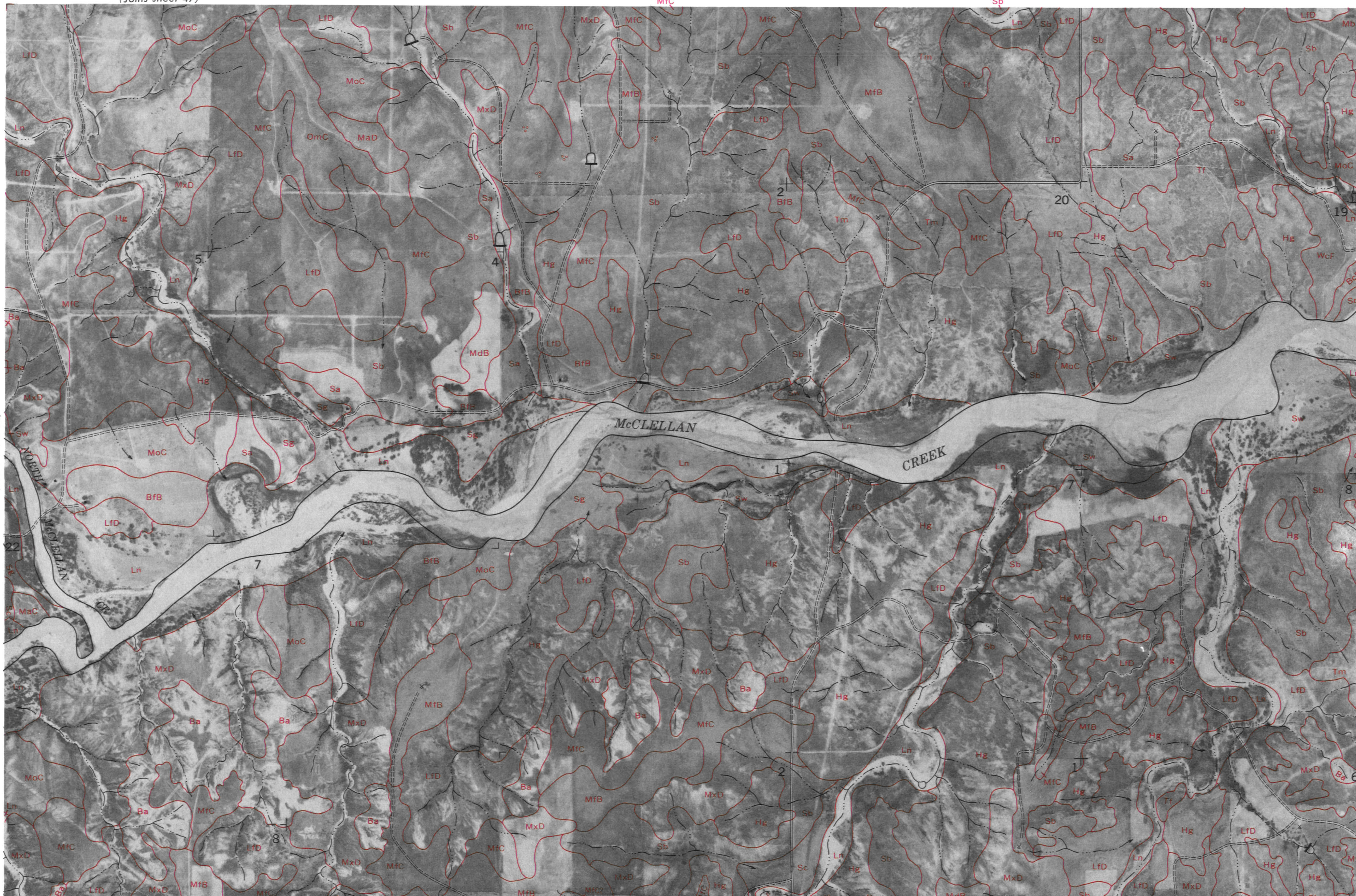
Land division corners and numbers shown on this map are indefinite.

54

GRAY COUNTY, TEXAS — SHEET NUMBER 54

(Joins sheet 47)

(Joins sheet 53)



(Joins sheet 55)

(Joins sheet 61)

0 ½ 1 Mile

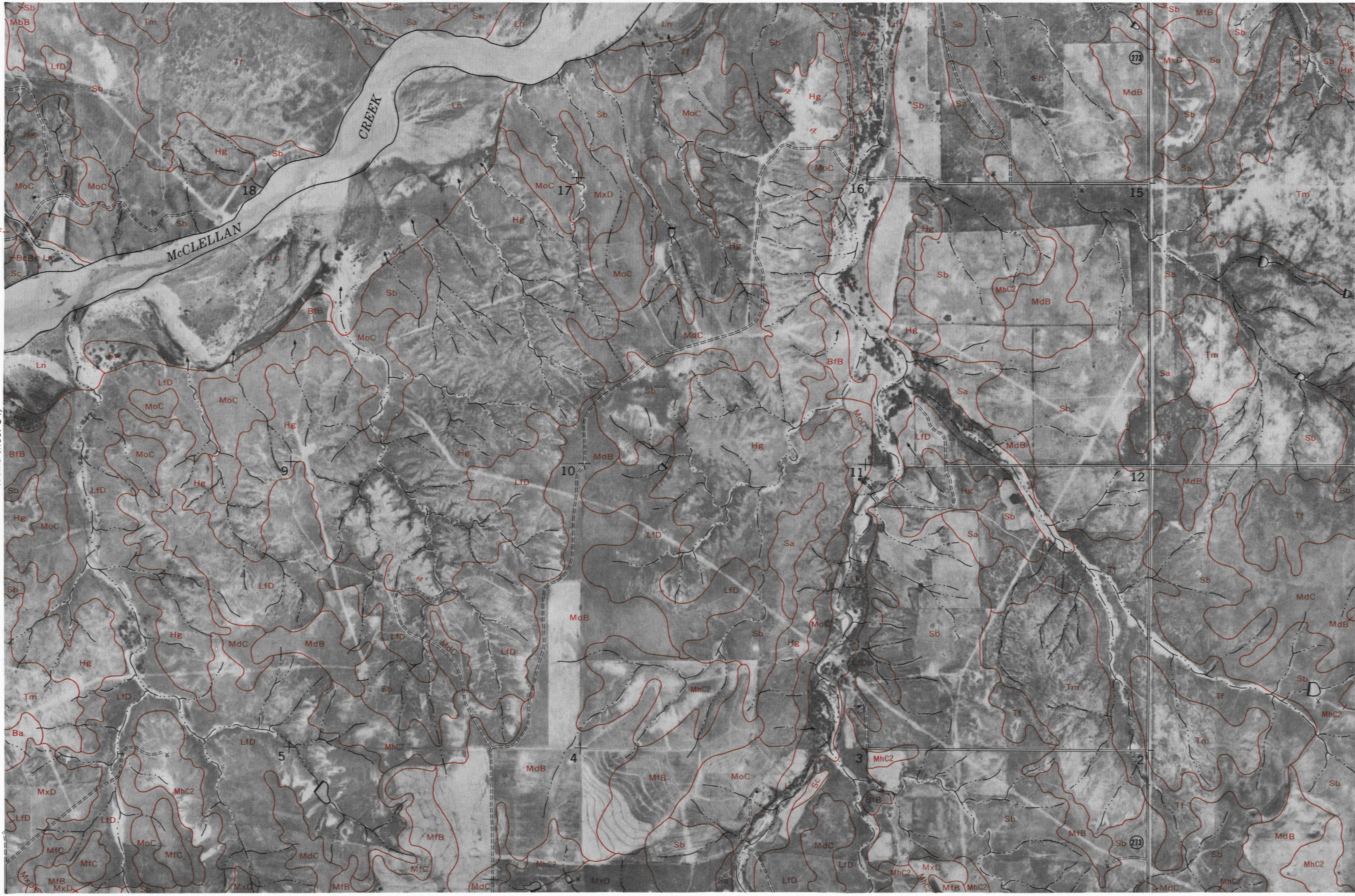
Scale 1: 20 000

0 5000 Feet

(55)

(Joins sheet 48)

(Joins sheet 54)



(Joins sheet 56)

(Joins sheet 62)

0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

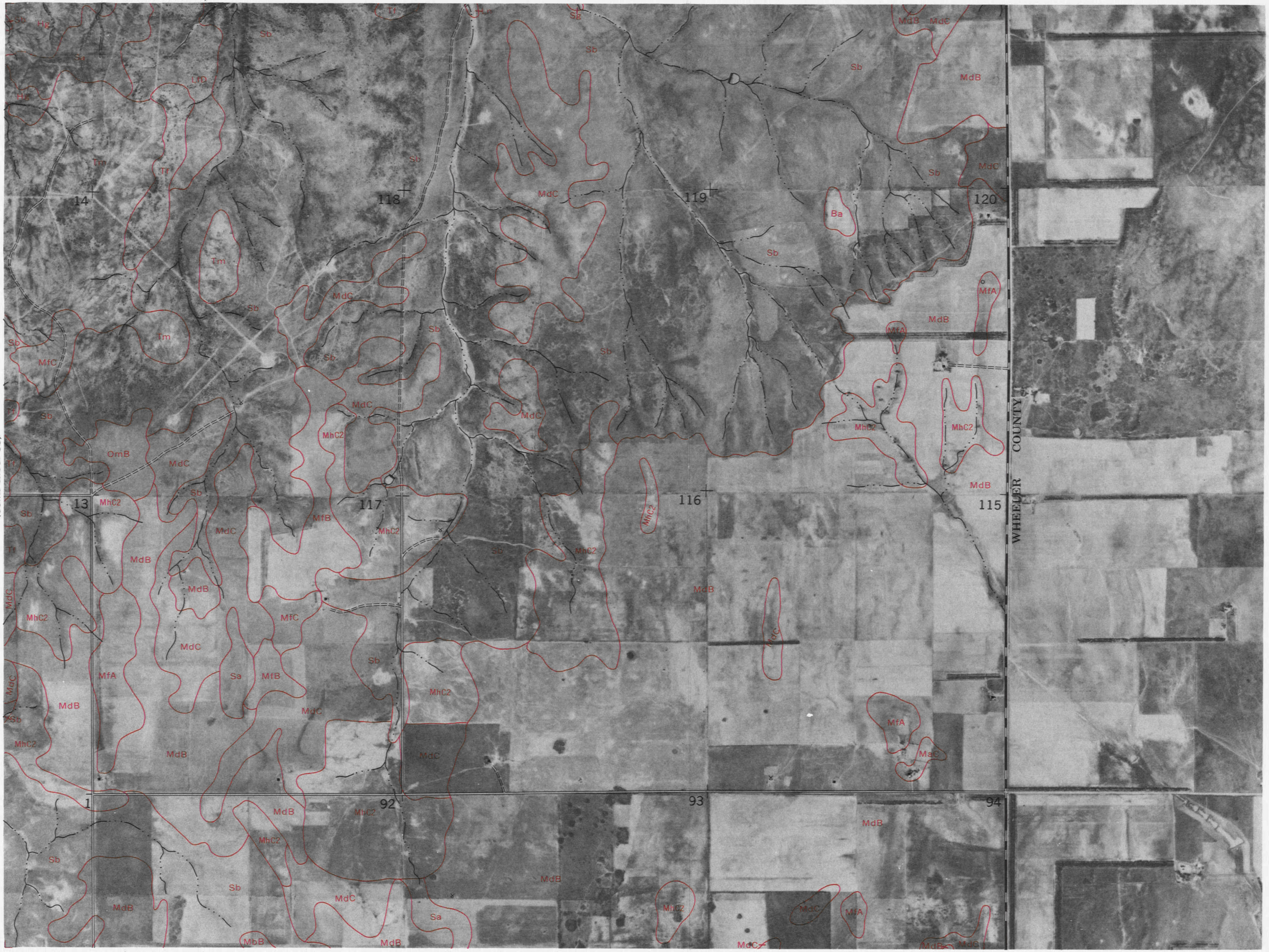
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

GRAY COUNTY, TEXAS — SHEET NUMBER 56

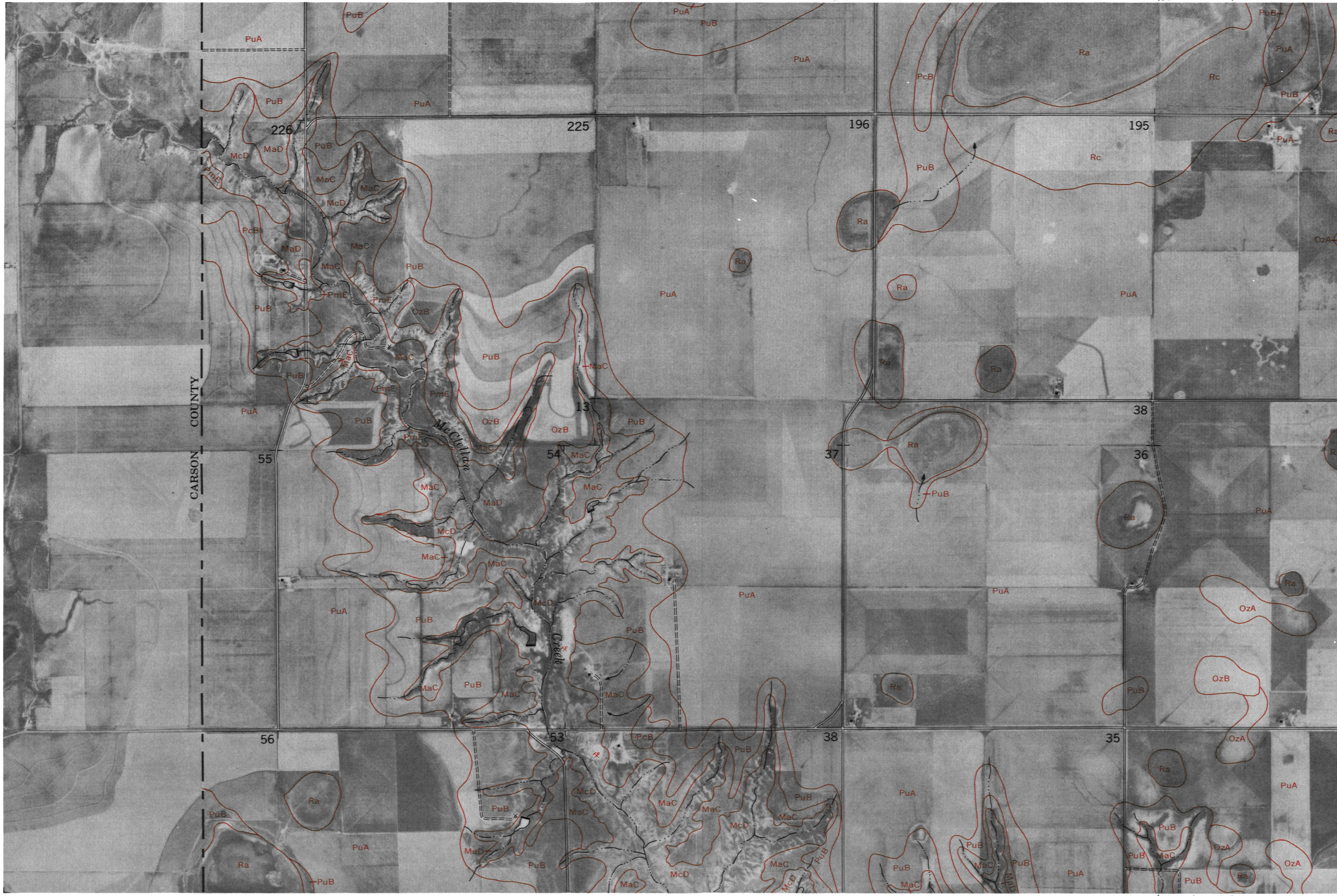
56

(Joins sheet 49)



(Joins sheet 63)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

(Joins sheet 51)

(Joins sheet 65)

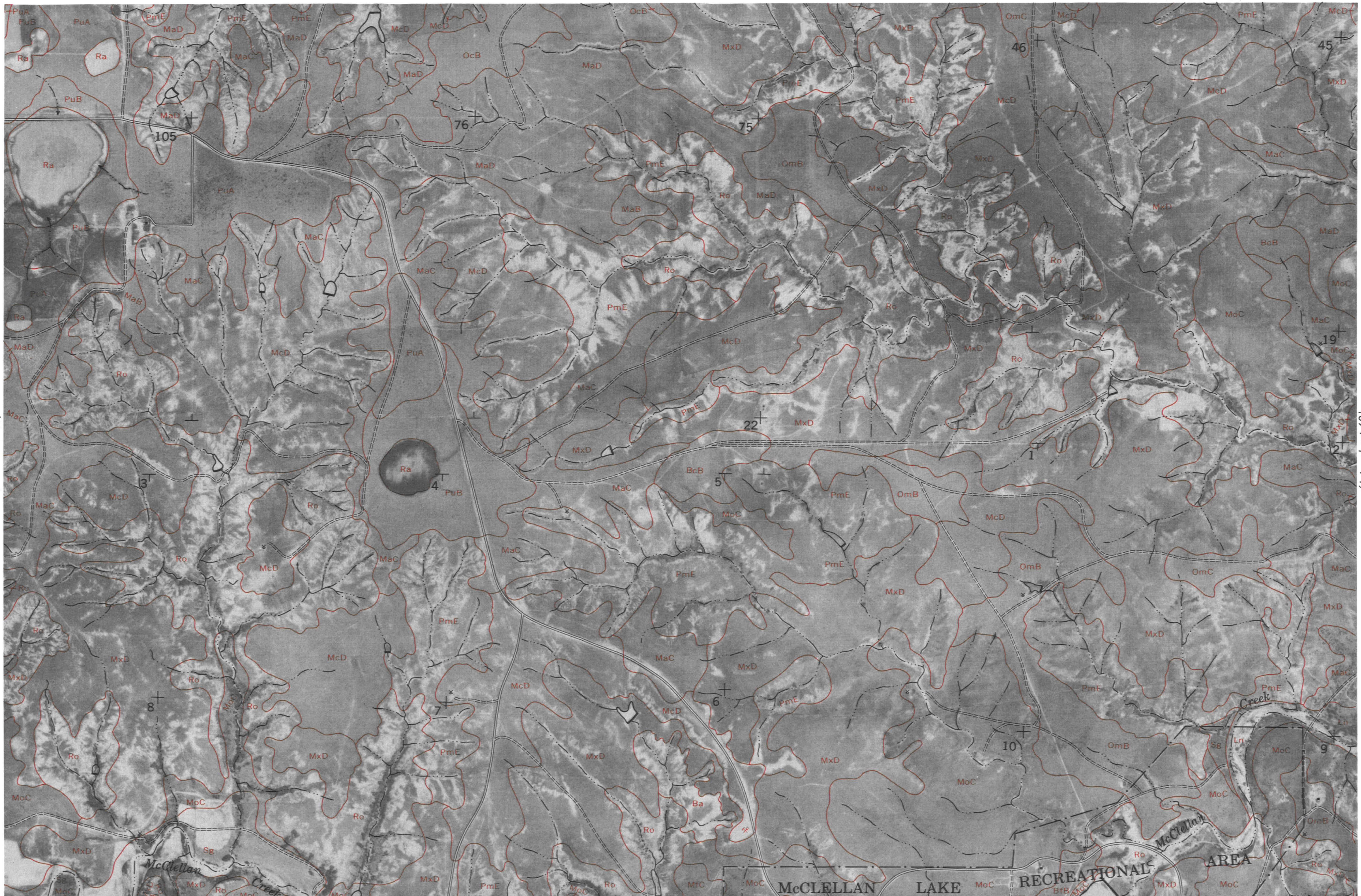
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

(Joins sheet 52)

(Joins sheet 58)

(Joins sheet 60)

N



(Joins sheet 66)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

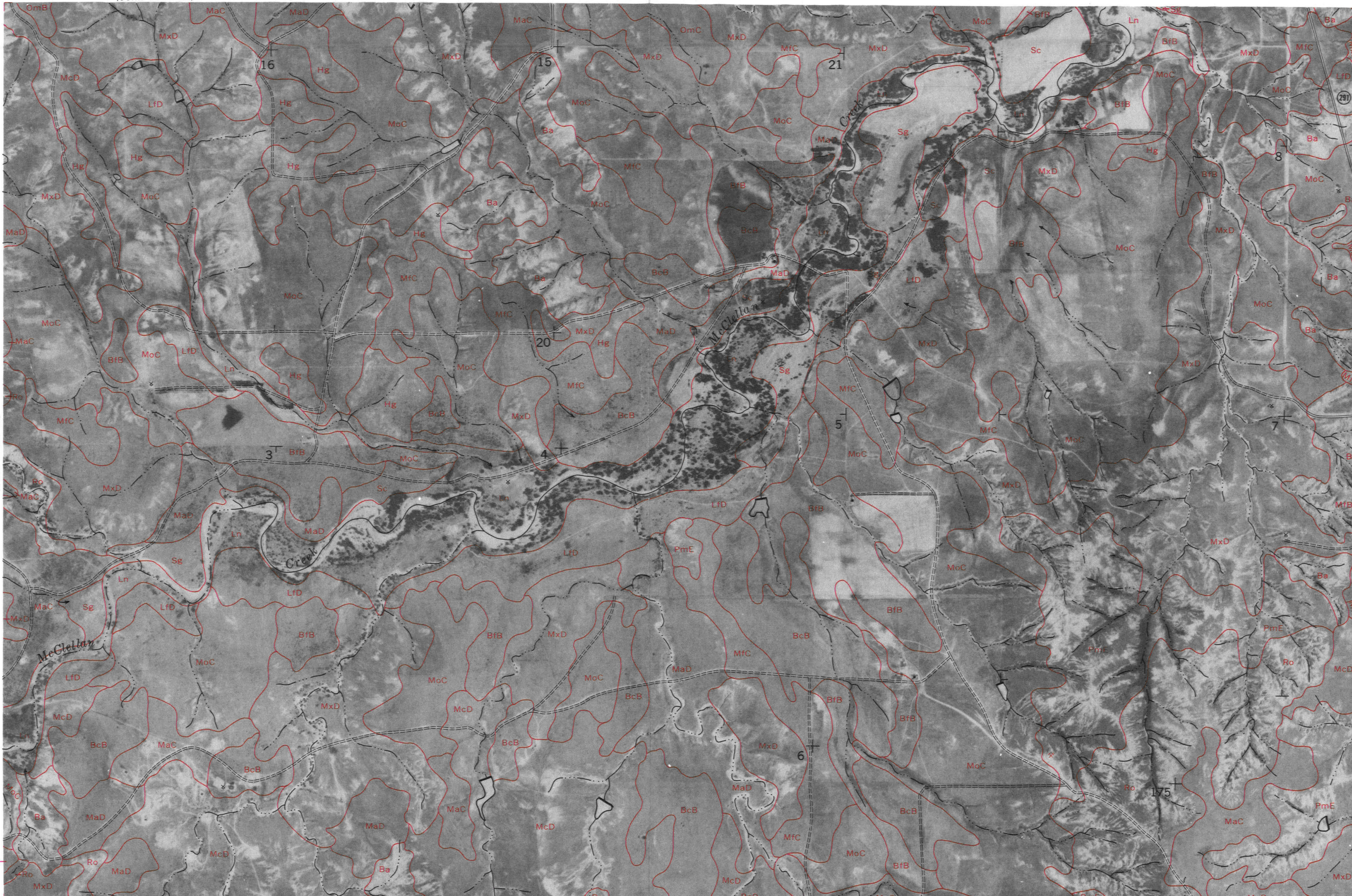
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

GRAY COUNTY, TEXAS — SHEET NUMBER 60

(Joins sheet 53)

(Joins sheet 59)



(Joins sheet 61)

(Joins sheet 67)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

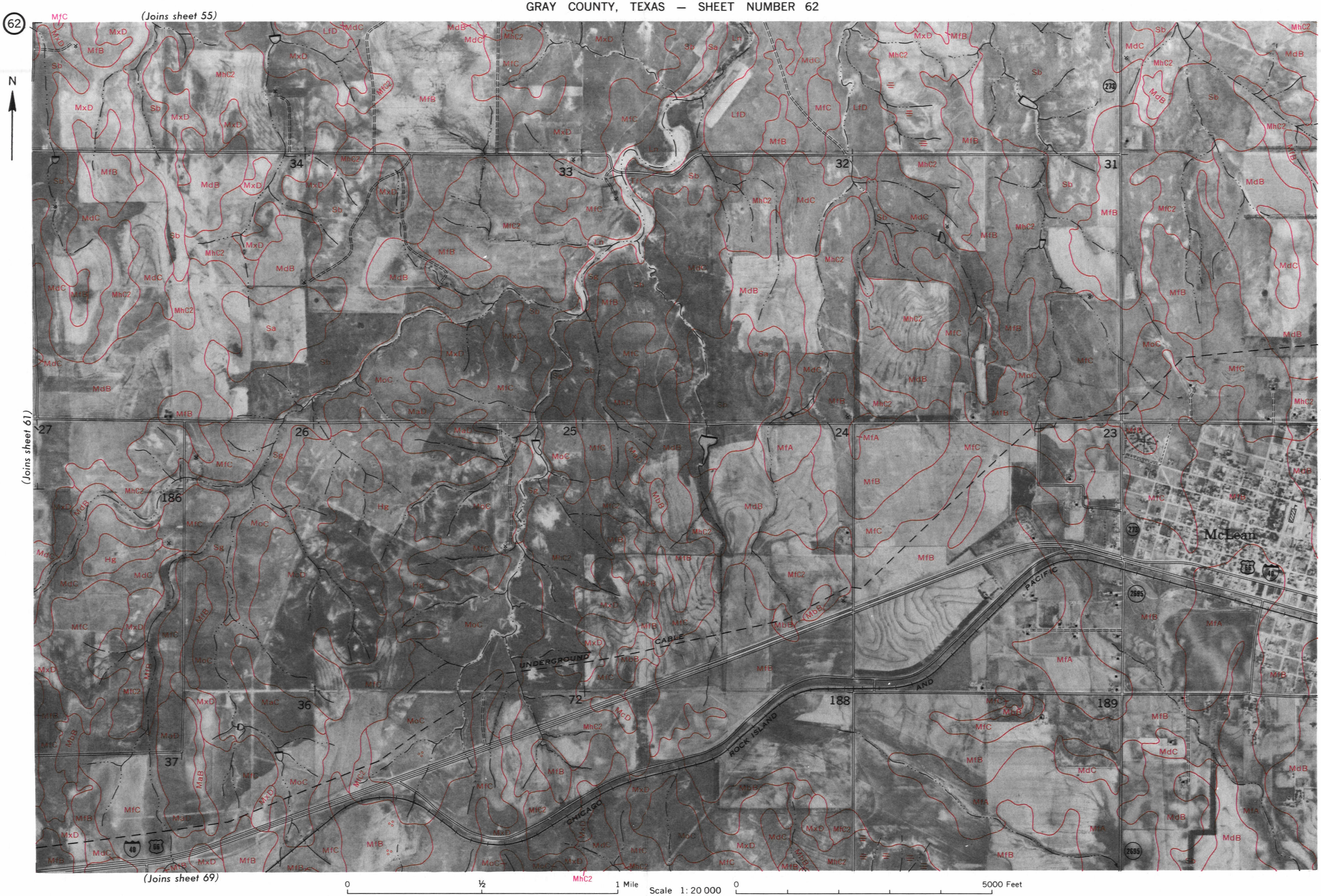
GRAY COUNTY, TEXAS — SHEET NUMBER 61

61

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States *Department of Agriculture*, and the Texas Agricultural Experiment Station.

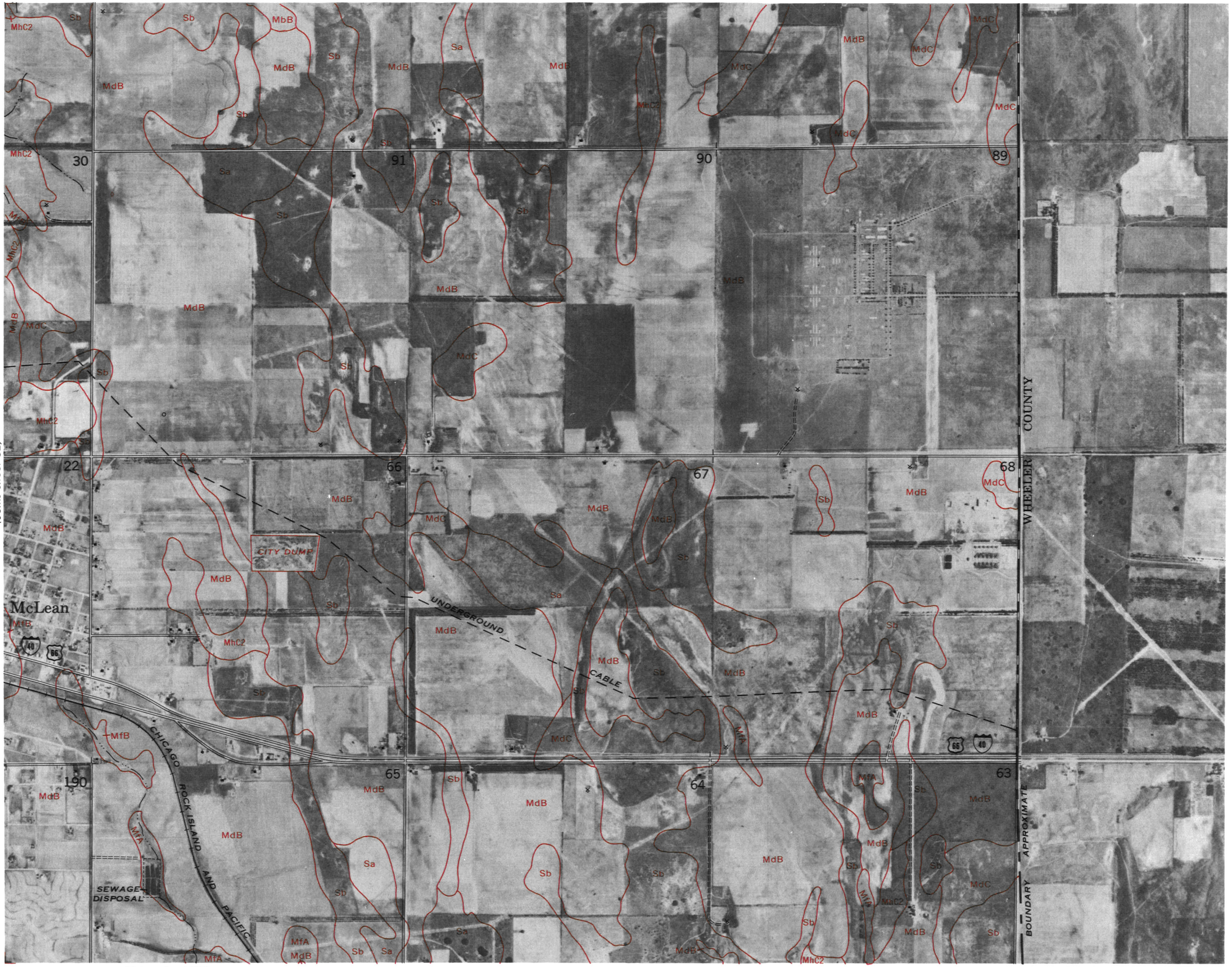
Land division corners and numbers shown on this map are indefinite.


62
N
(Joins sheet 55)
(Joins sheet 61)
(Joins sheet 63)
(Joins sheet 69)
McLean
UNDERGROUND CABLE
CHICAGO ROCK ISLAND AND PACIFIC
0 ½ 1 Mile
Scale 1: 20 000
0 5000 Feet

63

(Joins sheet 56)

(Joins sheet 62)



N

(Joins sheet 70)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

GRAY COUNTY, TEXAS — SHEET NUMBER 64

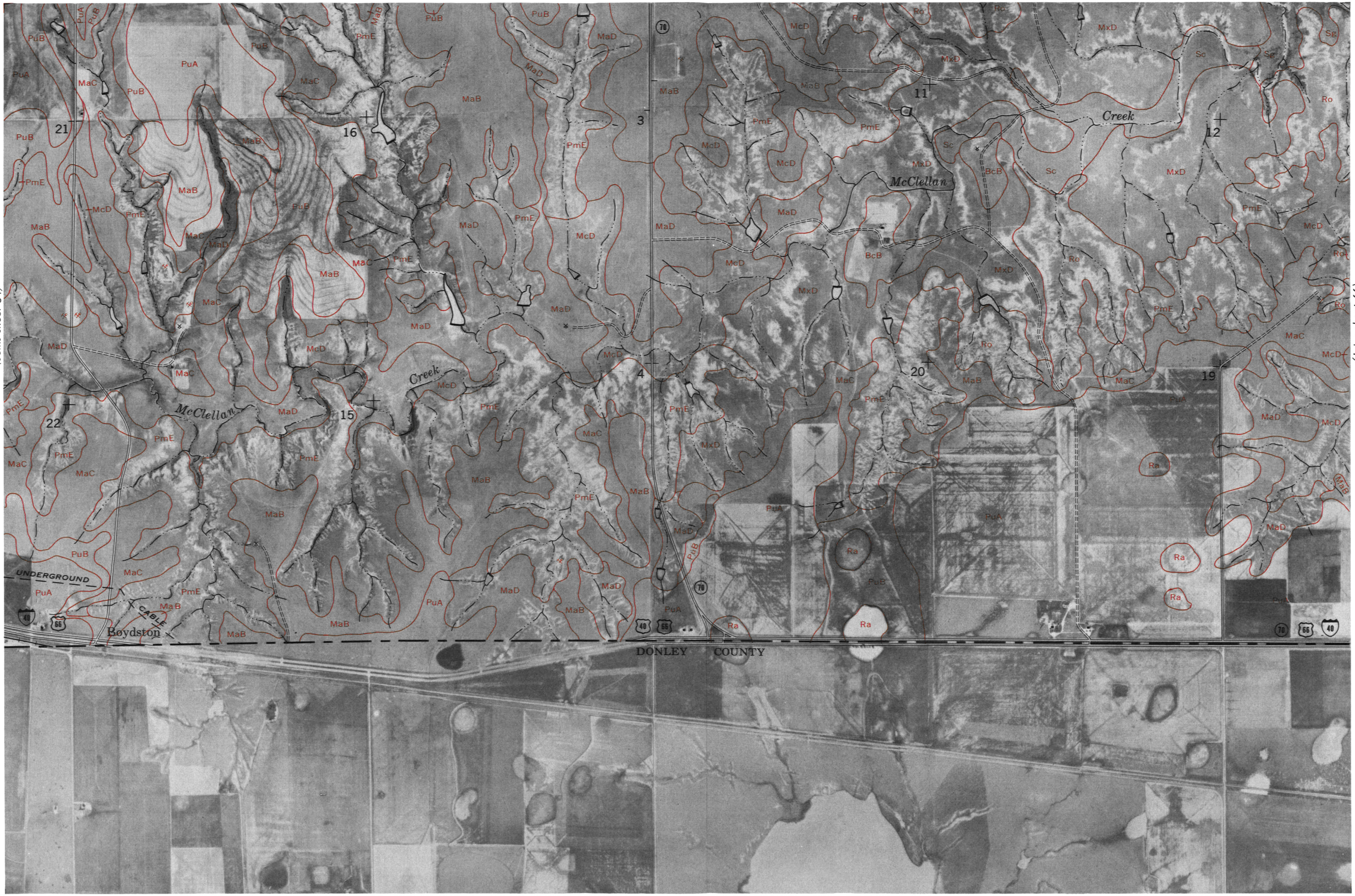
(Joins sheet 57)

(Joins sheet 65)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

(Joins sheet 58)

65



This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners and numbers shown on this map are indefinite.

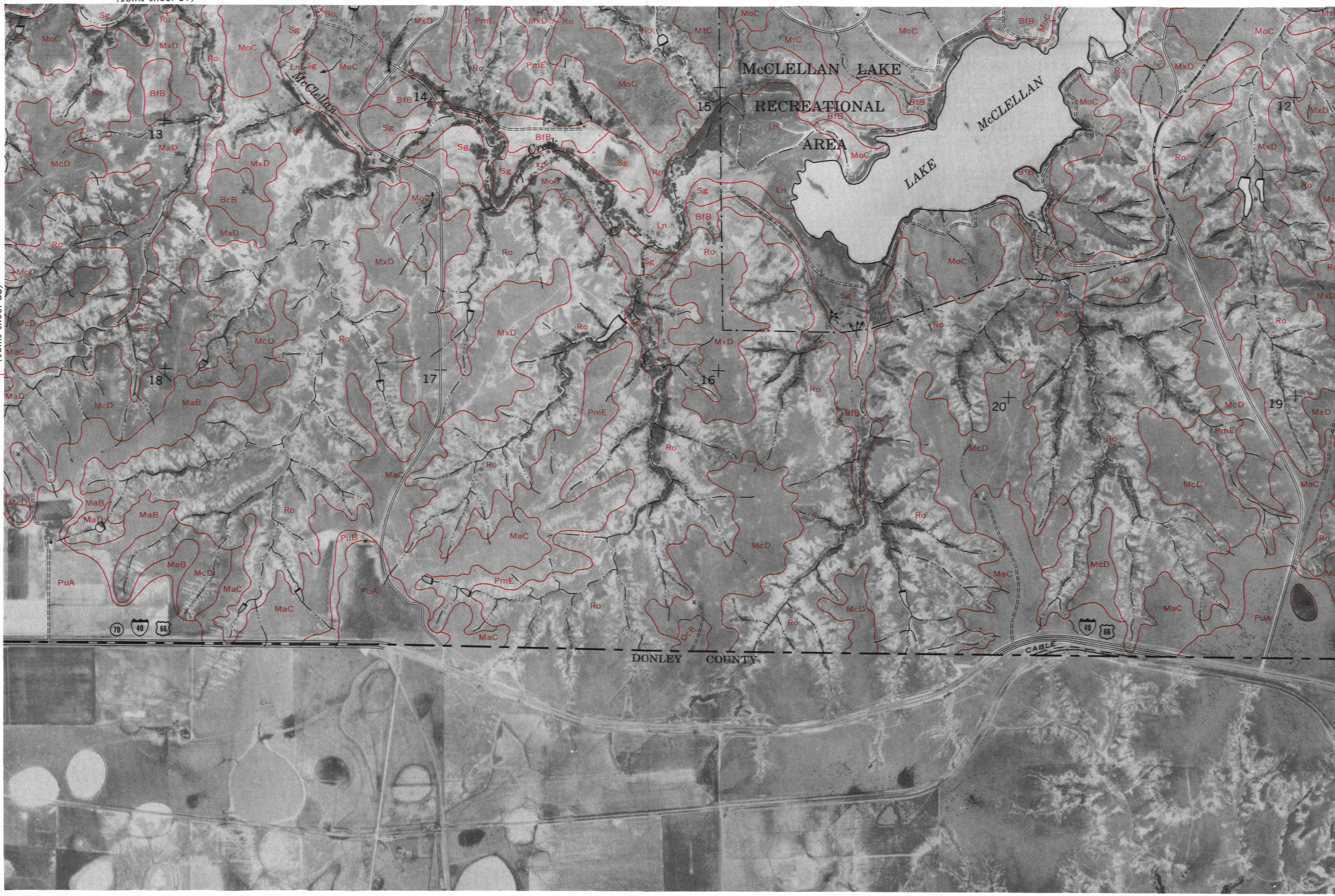
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

(Joins sheet 59)

N

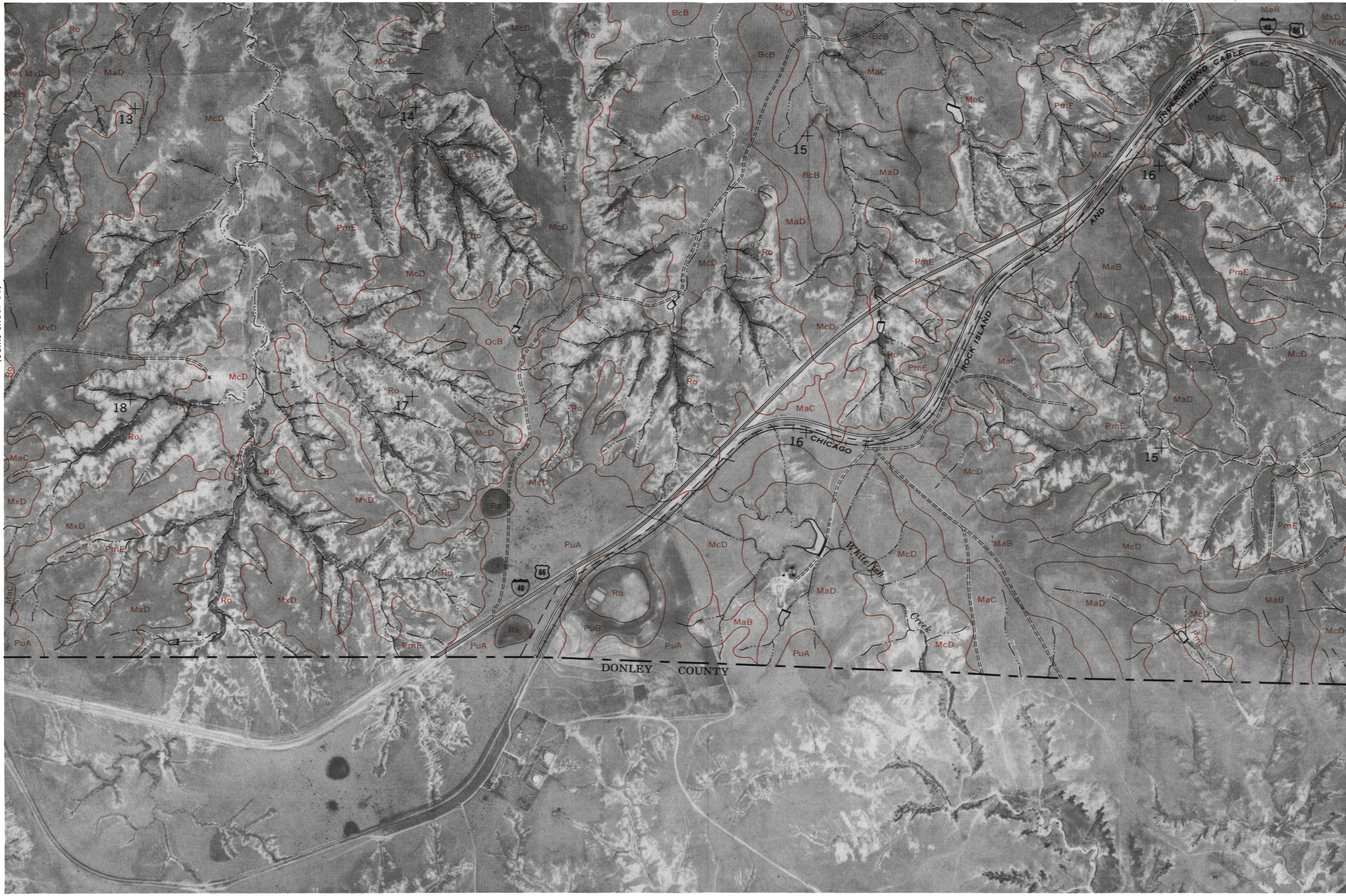
(Joins sheet 65)

(Joins sheet 67)



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

(67)



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

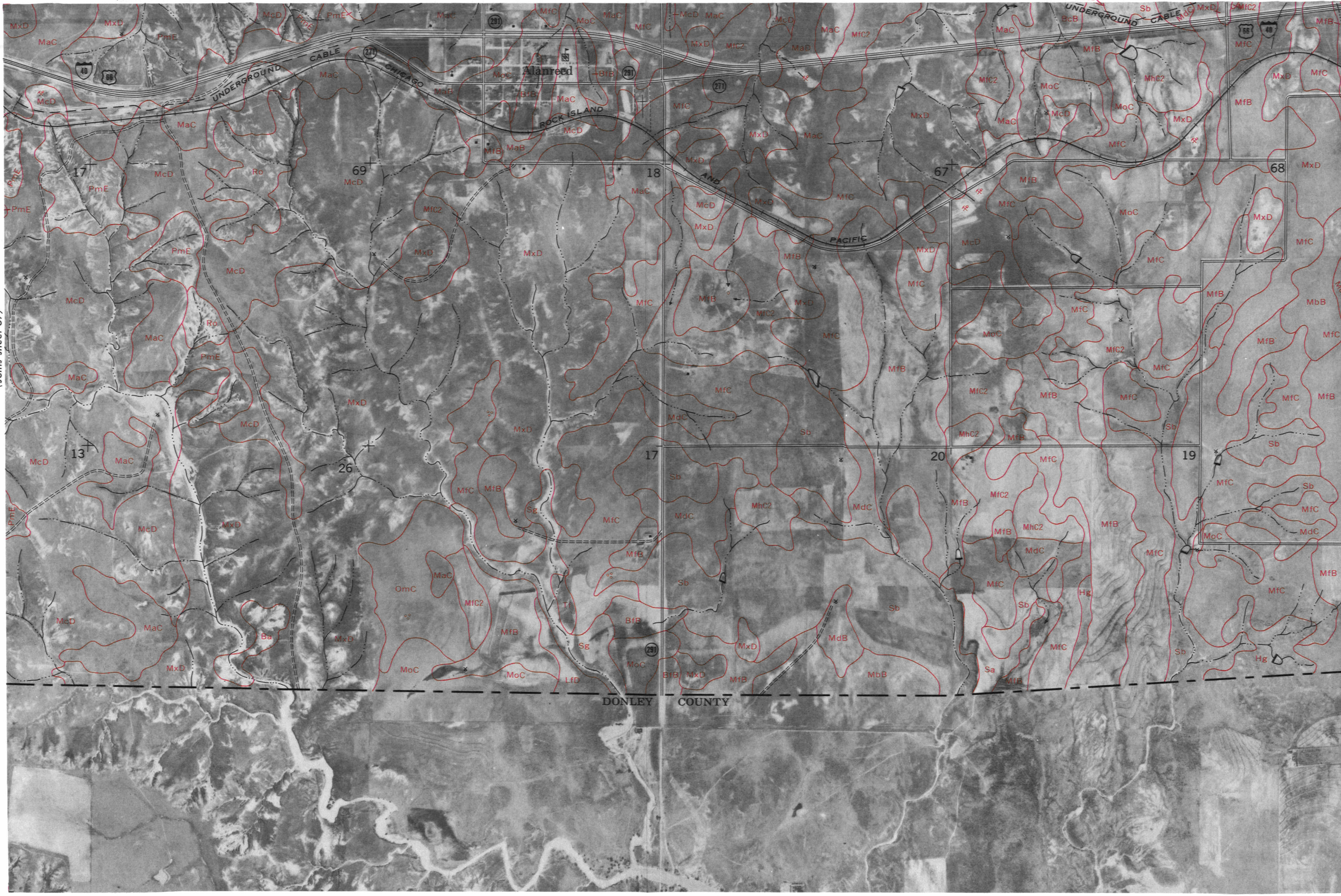
Land division corners and numbers shown on this map are indefinite.

GRAY COUNTY, TEXAS — SHEET NUMBER 68

(Joins sheet 61)

N

(Joins sheet 67)



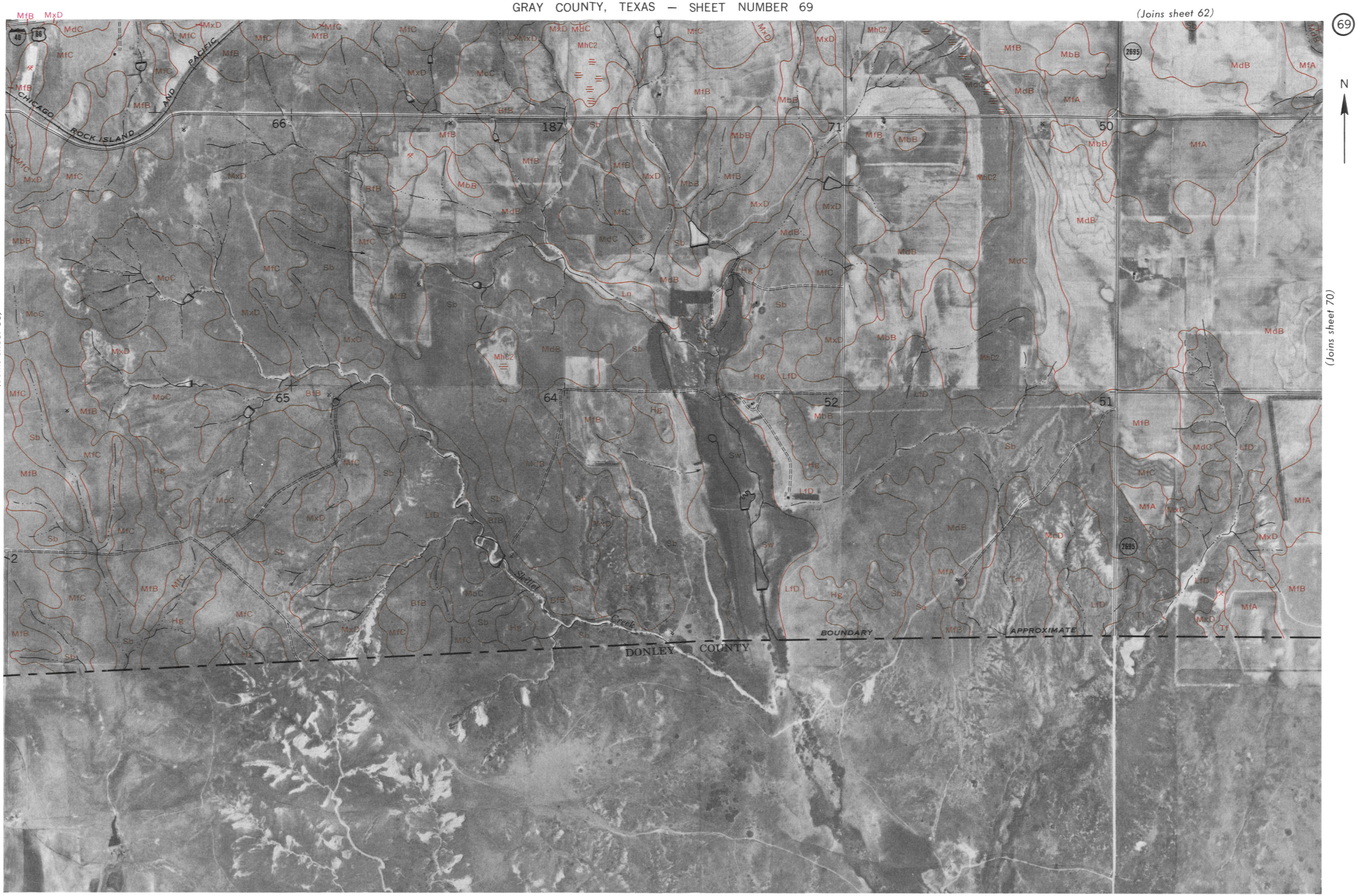
(Joins sheet 69)

0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

(Joins sheet 62)



0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of *Agriculture*, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite.

70

(Joins sheet 63)

N

(Joins sheet 69)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet